Science and Invention

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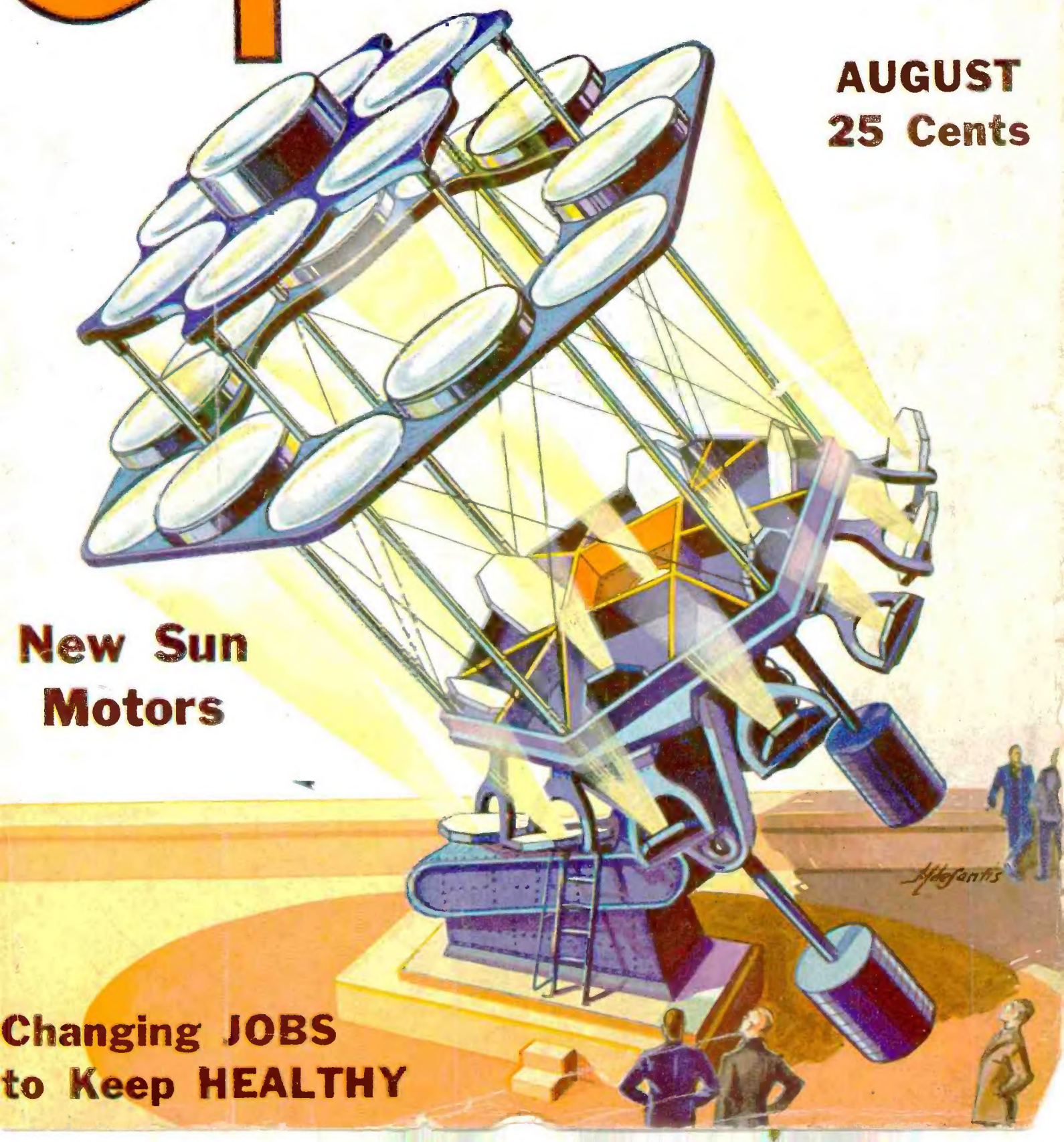

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I start many in Radio at two and three times what they were making before

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EVER so often a new business is started. You have seen how the men who hooked up with the automobile, motion picture and other industries at the right time are now the $5,000, $10,000, $15,000 a year men—independent, satisfied. The same opportunities they had in those industries—the chances that made them rich, are now being offered you in Radio. Radio's growth has already made hundreds of men wealthy. Many more will become rich and independent in the future. Get one of these fine jobs for yourself.

Radio's big growth making hundreds of fine jobs every year

I am doubling and tripling the salaries of men and young men by training them for Radio's good jobs. My training fits you for Radio factories, broadcasting stations, a spare time or full time business of your own, operating on board ship—which gives you world-wide travel without expense, commercial land stations, research laboratories and many other branches. Talking Movies, Public Address Systems, Radio in Aviation, Television, Advanced Servicing and Merchandising and other valuable subjects are covered in my course.

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The day you enroll I will show you how to do 28 Radio jobs common in almost every neighborhood. Throughout your course I'll show you how to do many other jobs for extra money. G. W. Page, 2210 Eighth Ave., S., Nashville, Tenn., made $935 in his spare time while taking his course. Joseph Skrivanek, 20 Telegram Ave., Elmont, L. I., N. Y., says: "My total earnings since my enrollment amount to $2,892 for spare time work in evenings."

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ACT NOW—
Find out what Radio offers you for success and bigger pay

My book gives you the facts, what your prospects are for a job and quick promotions, how you can get in without delay, what you can make. It explains my practical method of training with my home experimental laboratory, what my Employment Department does to help you find a job upon graduation and many other features that have made N. R. I. training unequalled. There is no obligation. Simply fill out the coupon below and mail it. Do it today.

J. E. SMITH, President
Dept. IHS
National Radio Institute
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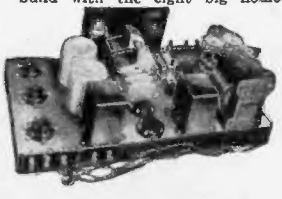

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National Radio Institute, Dept. IHS
Washington, D. C.

Dear Mr. Smith: Without obligating me send your book explaining Radio's opportunities for bigger pay and your method of training men at home in their spare time to become Radio Experts. I understand that this places me under no obligation and that no salesman will call.

Name.....

Address.....

City.....*State*.....

AUGUST
1931

Science and Invention

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Published Monthly by **Radio-Science Publications, Inc.**, Jamaica, N. Y.

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EDITORIAL AND EXECUTIVE OFFICES
381 FOURTH AVENUE, NEW YORK CITY, N. Y.

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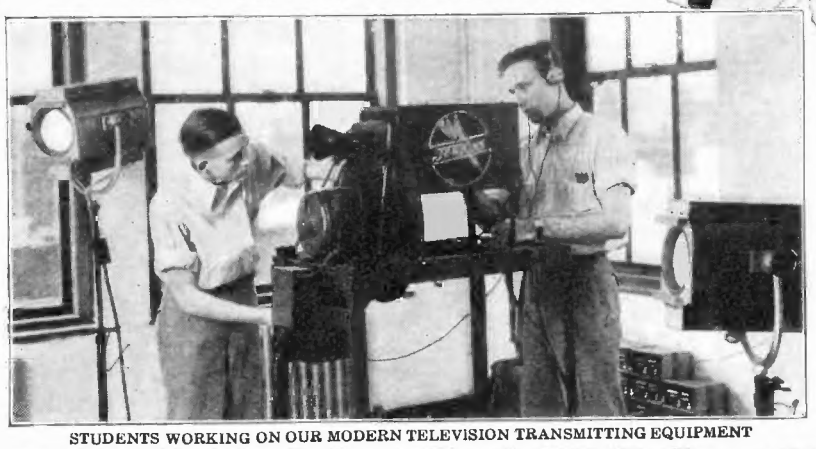

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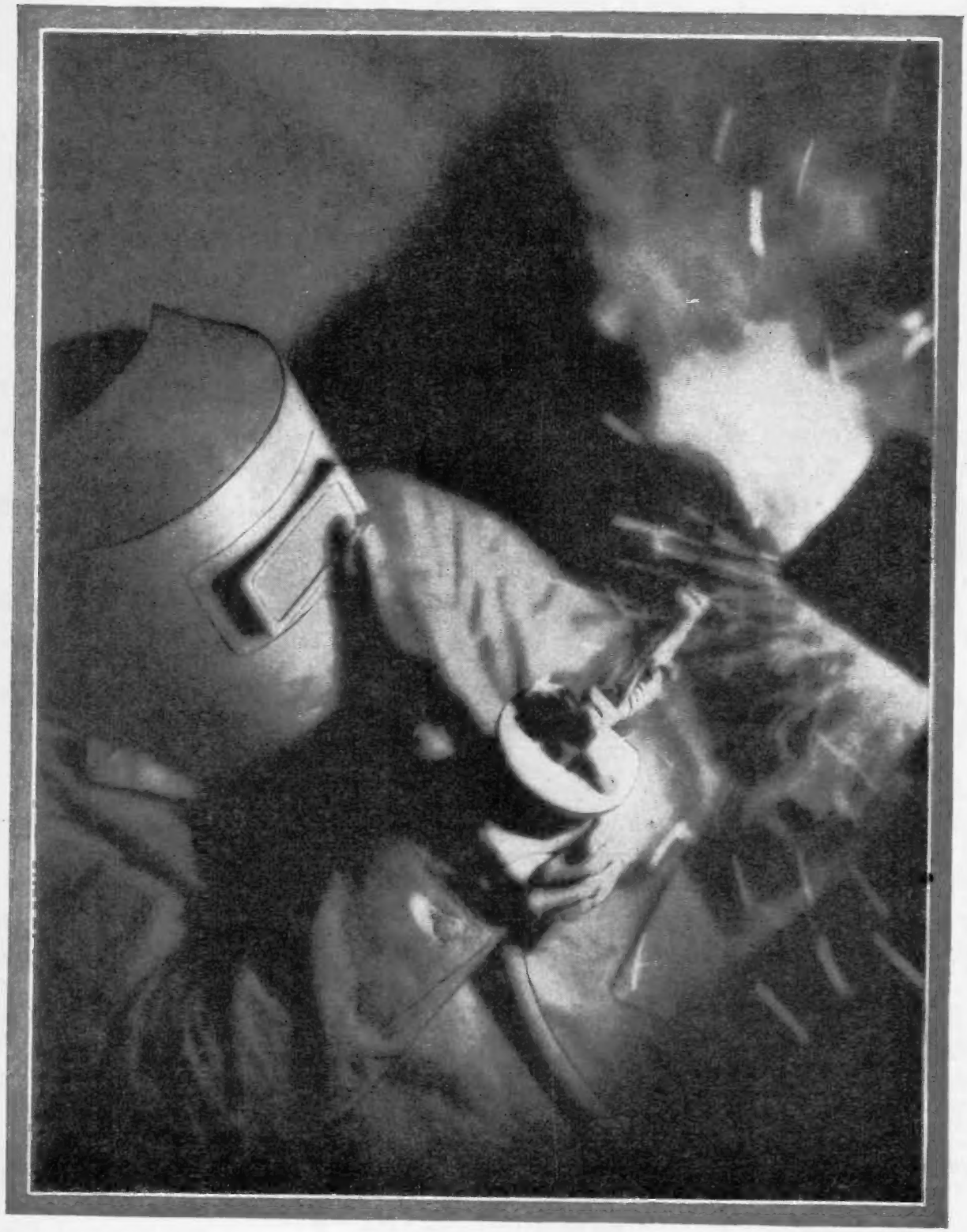

Photo Ewing Galloway

The Grotesque Figure Shown Here Is the Result of One of Science's New Industrial Processes, Arc Welding. To Protect the Operator Against Sparks and, More Particularly, Protect His Eyes and Face from the Injurious Effects of Ultra-Violet Rays, It Is Necessary for Him to Wear This Fearsome-Looking Mask. See Article Entitled "Changing Jobs to Keep Healthy," in This Issue.

AUGUST, 1931
WHOLE NO. 220

Science and Invention

NUMBER 4
VOLUME XIX

Published by Radio-Science Publications, Inc., 381 Fourth Ave., New York City, N. Y.

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Editorial

MANY of the ills to which human flesh is heir have been found to be directly traceable to defects in diet. For example, Doctors G. B. Eusterman and O. P. O'Leary of the Mayo Clinic, reporting recently on a series of cases, showed that lesions in the digestive tract develop prior to a secondary pellagra—an endemic skin disease sometimes called "Italian Leprosy." It has been further established that a characteristic of vitamin "A" deficiency, known as xerophthalmia, is secondary to inability to digest and absorb food. Xerophthalmia is an inflammation of the delicate membrane that lines the eyes; with wasting away, and with abnormally dry and lustrous eyeballs.

So, perhaps medical science will ultimately correct digestive disorders by the daily administration of the known vitamins and others yet to be discovered. Perhaps, the proper doses of vitamin will make for the formation of perfect teeth and bones; and when medical science gets thus far, it will be possible for members of the fraternity to stop the growth of bones whenever they desire and so produce beings of relatively even height and weight. They may even delay the growth of hands and feet, so that members of our fairer sex will all present perfect appendages.

Improbable today, you will say. Yes, but not impossible.

IN the April, 1931, issue of this publication, Sir Ambrose Fleming, F.R.S., in his article entitled: "My Wireless Memories and Inventions," referring to his invention of the Fleming valve, wrote:—

"As a claim has been made by Irving Langmuir to have made a patentable improvement by making the vacuum a high one, I should like to point out that in my original patent specifications for this valve, the necessity for a high vacuum is clearly stated."

Sir Ambrose Fleming then quotes from his U. S. patent specifications, dated April 19, 1905, to prove this point.

On May 25th last, the DeForest Radio Company won a suit against the General Electric Company, which controls the Langmuir patent. It was decided by the court that "It did not need the genius of the inventor to recognize and act upon the truth that a better tube for amplifying could be made by taking out the gas." Also . . . . "increase of vacuum in well-known devices was all that was necessary to produce the desired result."

This decision makes the Langmuir patent invalid because of anticipation, want of invention, prior invention and prior use.

It is a good thing for our budding inventors to know that these requisites make for a basic patent.

OUT in California, the broadcasting stations have developed their own censorship. Soothsayers and mystics who deliver fortunes over the air have felt this censorship. They have a radio newspaper, "California Broadcaster," to take up the cudgels for the public.

Now, if some of the stations on the East Coast would censor their programs more, and delete some of the advertising which is extremely obnoxious to the listener-in, and if they would also throw out those medical quacks whose advertising will not be accepted by reputable newspapers and magazines, and clean up the would-be mystics, the air would become peaceful and enjoyable again.

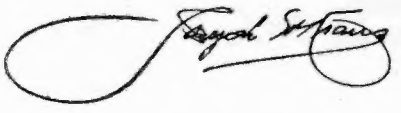
NO sooner does science develop a new food or ingredient of food, than the entire country grasps the straw, inscribes it as a panacea for all ills, and capitalizes upon the efforts made by men who are earnestly trying to discover benefits to human bodies.

Not so long ago electricity and magnetism were advertised as cures. There were electric belts, electric hair growers, magnetic and electrical combs, electric insoles for foot troubles, etc. Then these things died out and other frauds were perpetrated, such as the Oxydonor, Oxypathor and Oxybon. These were small metal tubes, which were to be placed in a basin of water where they "extracted the oxygen from the water," and fed it to the body through a rubber tube held in contact with the skin. Then glandular extracts of all kinds became panaceas. Following these preparations we arrived at the electro-magnetic belts, such as the Ionaca. It now seems that the sun-ray devices will enter into the field heretofore held by other alleged cures. Fortunately, sun-rays possess properties that are of distinct benefit. This is not so with frauds of the past. But sun-ray machines are not cure-alls.

To show the ridiculous extent to which these things are played up to the public, there is a laundry in Chicago that is subjecting all clothes to sun-ray treatment, after the materials have been thoroughly washed in boiling hot water to which ammonia may have been added, rinsed and dried.

So now, in addition to tobacco, bread, ice cream and cereals being sun-rayed, we may also have clothes, collar buttons and socks treated with ultra-violet light so that these items might also acquire health-giving properties.

Isn't this linen treatment exploiting science too far?



"Those Who Refuse to Go Beyond Fact Rarely Get as Far as Fact" - - - - - - - - HUXLEY

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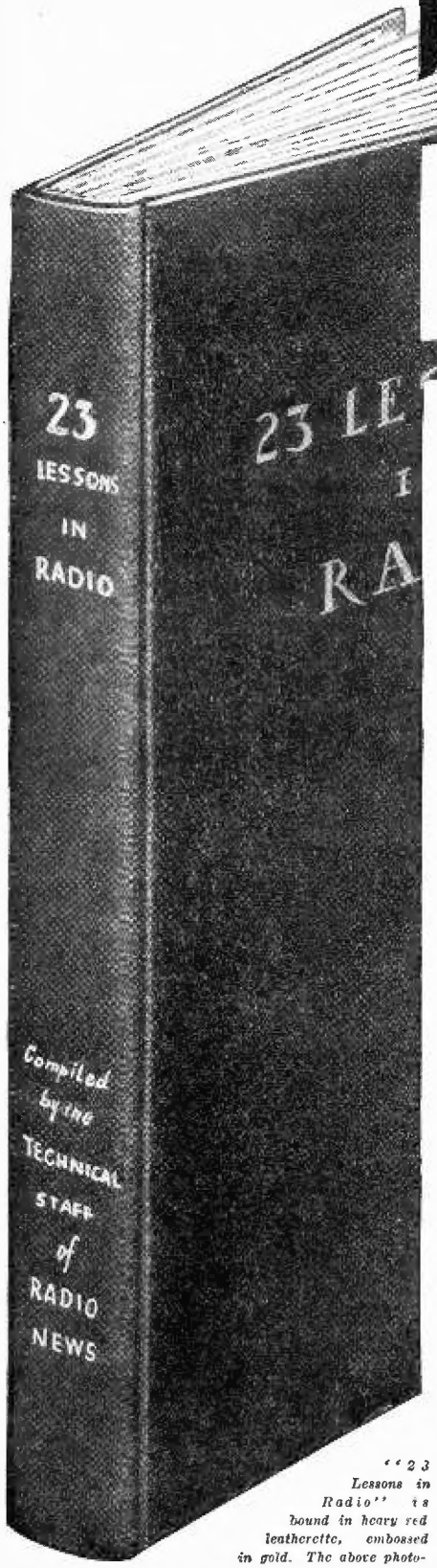

"23 Lessons in Radio" is bound in heavy red leatherette, embossed in gold. The above photograph is actual size.

SO many requests have come into this office asking us for a book covering the Junior Radio Guild lessons, that we have at last, with considerable time and effort, compiled this material (along with some other information) into a great new book!

Boys just beginning radio training — young men needing a reference book which contains the fundamental principles of radio—more experienced men wanting the *latest* dope on the essentials—all will find "23 LESSONS IN RADIO" the answer!

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How the Radio-Frequency Amplifier Works
How To Build a "Converter" which changes your 5-tube broadcast receiver into a Short-Wave receiver
Principals of transmitting and receiving
Complete Chart of Standard Radio Symbols
How To Build R F Tuner
How To Build a 3-stage resistance coupled audio-frequency amplifier
The How and Why of B-Power Units
Breaking into the Amateur Game
How to build a code test outfit:
Circuit, constructional and operating details of a Low-Power Transmitter
How the Vacuum Tube Works
Battery construction and how they work
How to Analyze Receiver Circuits

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All radio men know the tremendous value of a good background in this field. To be well grounded in the first essentials is the kernel which develops success!

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AUGUST, 1931
WHOLE NO. 220

Science and Invention

VOLUME XIX
NUMBER 4

Changing Jobs To Keep Healthy

"Shall I Change My Occupation? By All Means! If Your Occupation Is Unhealthy, It Needs Remaking According to Hygienic Standards," Says the Author of This Amusing and informative Article. "Every Occupation Is Unhealthy. But if You Know the Secret of Industrial Hygiene, You Can Snap Your Fingers at Occupational Disease."

By Dr. Frederic Damrau, M.D.

As healthy as a sailor. The picture conjures up a ruddy-cheeked, brawny-armed gob with hair on his chest. But those who follow the sea can tell us best how sailors really live.

"You are going to make him a sailor, I judge," I commented to the officer of a freighter a few years ago, as his son passed us on the street. "Not him!" was the reply. "If I have anything to say about it, I shall never permit a son of mine to follow the sea. It's too unhealthy."

The grass always seems greener in somebody else's yard. Or perhaps I should say the waves are bluer under somebody else's ship. Yet, when I took a short trip aboard my friend's freighter, I found out what he meant. As an experience, the trip was a landlubber's adventure; but if I must go down to the sea in ships again, it will be as a passenger.

The sailors bunked in overcrowded and dirty quarters, with practically no ventilation. Their bunks were always damp and chilly. There were no facilities for keeping clean. The food was poor, swimming in grease and eaten on the run.

No wonder the old-time sailor seized every opportunity to hop ashore with a bottle of whisky under one arm and a lady of indifferent morals on the other.

Legislation is gradually improving conditions such as these, but because of them it is easily understood why pneumonia and tuberculosis prevail among sailors on freighters.

Girl workers in an English bottling factory are protected against exploding bottles by wire masks and thick woolen gloves.

If you chose your occupation as most people do, you followed the lead of your immediate friends or relatives. Another motive was, perhaps, the amount of money or the social position you thought would accrue to you. It is just as well, perhaps, that these were your motives, for if you attempted to choose what you considered an entirely healthy occupation it might take you a long time to catch your will-o'-the-wisp.

Once there was a jovial rover who said he would try anything once. He tried mining, and got anthracosis. So he gave up mining, took a job as policeman and got varicose veins. He gave up his beat to go into farming on sunny, southern acres. One day he went barefooted in the fields and got hookworm disease. Determined to find a healthful occupation, he gave up all jobs and became a hobo.

"Now here ought to be a healthy occupation," he mused, "plenty of sunshine and fresh air with nary a worry to speak of." But when heating his mulligan over a wayside fire, the wind swirled the smoke about him. Soon he began to get all hot and bothered. His face and hands swelled up and he broke out into torturing, itching tetters. Of course he didn't know it was poison oak he burned and that the smoke carried the resinous irritant, *toxicodendrol*.

Our jovial rover next got sense, took up the occupation which interested him most and lived happily ever after, or at least his allotted three score and ten. He had discovered the secret formula. You remember the doggerel:

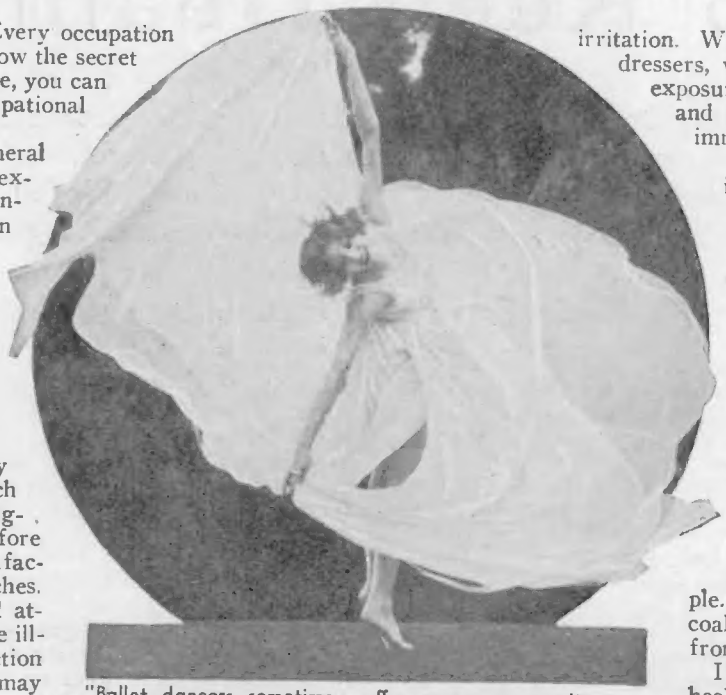
"Big fleas have little fleas upon their backs to bite 'em.
And lesser fleas have smaller fleas, and so *ad infinitum*."

Coal miner wearing goggles and an electric headlamp, both safety measures.

So it is with occupations. Every occupation is unhealthy. But if you know the secret formula of industrial hygiene, you can snap your fingers at occupational disease.

There are but a few general classifications required to explain the most spectacular dangers you may encounter when you go to work. Occupations which generate dust are notorious breeders of ill-health. Injurious vapors and the handling of highly poisonous chemicals in certain manufacturing processes engender specific and oftentimes terrible diseases. Such was "phossy jaw," which caused such shocking and painful disfigurement in match-makers, before legislation curtailed the manufacture of white phosphorus matches.

Unusual temperatures and atmospheric pressure may cause illness. Excessive use or friction of a portion of the body may cause a fatigue neurosis or local irritation. With such as slaughterers, skin-dressers, wool-, hair-, and rag-sorters, exposure to infectious, contagious and parasitic diseases is always imminent.



"Ballet dancers sometimes suffer severe spasmodic pain from over-development and partial dislocation of the great toe."

The surprising fact is that an industry which appears especially hazardous is oftentimes one of the healthiest. I was one of a party being escorted through a large coal mine near Scranton last fall, when a lady remarked to the physician in charge: "I should think miners would be especially prone to tuberculosis, working underground so continuously."

"On the contrary," he replied, "coal miners are three times as free from tuberculosis as other people. Strange to say, inhaling coal dust tends to protect lungs from t. b."

If you want to choose the healthiest occupation, be a clergyman. "Of the learned professions," says Doctor W. Ogle, "and indeed of all the occupations in our table, the Church enjoys the lowest death-rate." If the ecclesiastical calling has a characteristic ailment, it is clergyman's sore throat from exhortation against sin.

Next to the clergy, agricultural pursuits lead the list of healthful occupations. If you are a farmer, a horticulturist, a market-gardener or forester, start laying up your pennies against your old age, for you are promised many birthdays.

One of the queer occupational hazards which came to my attention a few years ago was "stamp-licker's tongue." The stamp-licker was employed usually in thread mills and factories where labels were utilized. One experienced lady "licker" could lick as many as eighty-five gross of labels a day.

The tongue of the stamp-licker always had a characteristic polished tip and frequently was the seat of small ulcers. Many of these girls suffered, also, from infected glands in the neck. Machinery competes with girls nowadays in stamp-licking, thus eliminating the above troubles.

Too little or too much air may be the undoing of those whose occupations cause them to work under unusual pres-

Ewing Galloway Photo

This gun applies cement to passage walls in coal mines to settle the coal particles and prevent explosions. It also helps to prevent miners' anthracosis, a disease of the lungs from breathing coal dust.

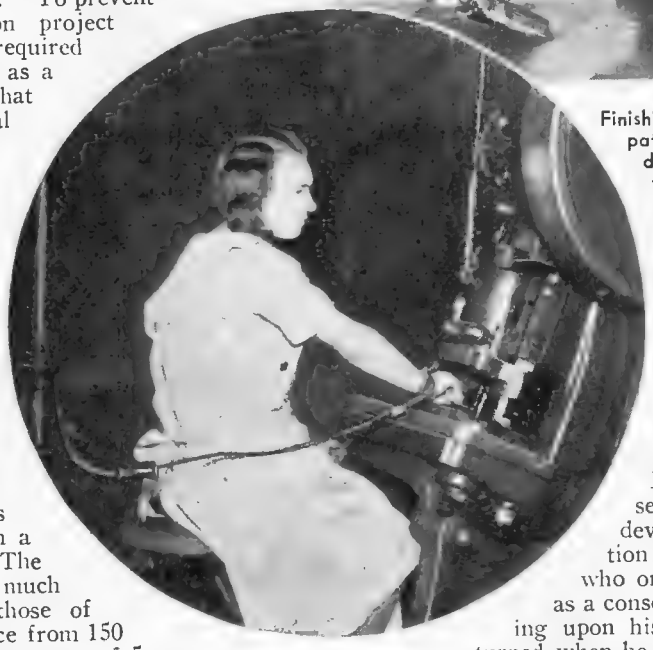
sure. At extremely high altitudes, the pressure is so diminished as to cause what the French call *"le mal des montagnes."* The worker whose occupation takes him to the high mountain top usually becomes acclimatized in a few weeks. Leonard Hill in his *Recent Advances in Physiology* reminds us that the highest dwelling place continuously occupied is the Observatory El Mirti, in the Andes, at three and one-half miles. He reminds us, also, that in Peru, Bolivia and Northern Chile a very large part of the population lives above two miles. Thousands visit the annual fair at Gartok in the Himalayas. This is 2.8 miles above sea level.

All construction engineers who work on projects where caissons are employed are familiar with caisson disease. It is caused by too quick a change from the increased pressure in the caissons back to normal atmospheric pressure. One of the serious symptoms is excruciating muscular pain. The workmen call this the "bends." To prevent this disease, every construction project working with caissons should be required to have decompression chambers as a part of the regular equipment, so that workmen may return to normal pressure very gradually.

One of the penalties of the machine age is the strain which monotony places upon the worker. Long repetition of a single movement sometimes produces the fatigue neurosis called occupational cramp.

Dr. Charles Aldrich, neurologist to the Cleveland General Hospital, was consulted some time ago by a man who complained of cramp-like pains, numbness and intermittent paralysis in the muscles of his right leg. When asked his occupation he said he had been a trap-drummer for twenty years. The muscles of his right leg were much more highly developed than those of his left leg, as they had to produce from 150 to 180 strokes per minute at a pressure of 5 to 25 pounds for each stroke. He was suffering from occupational cramp, which is caused by sustained, repeated movements requiring keen mental attention. His recovery was effected by gradually educating his left leg to relieve his right leg. A similar fatigue neurosis is the one called "dentists' leg," caused by standing continually in a strained position. Ballet dancers sometimes suffer severe spasmodic pain from over-development and partial dislocation of the great toe. A boiler-maker who once called at my office was deaf as a consequence of the repeated hammering upon his ear drums. His hearing returned when he left the boiler-shop and became a prize fighter. But then he got cauliflower ears.

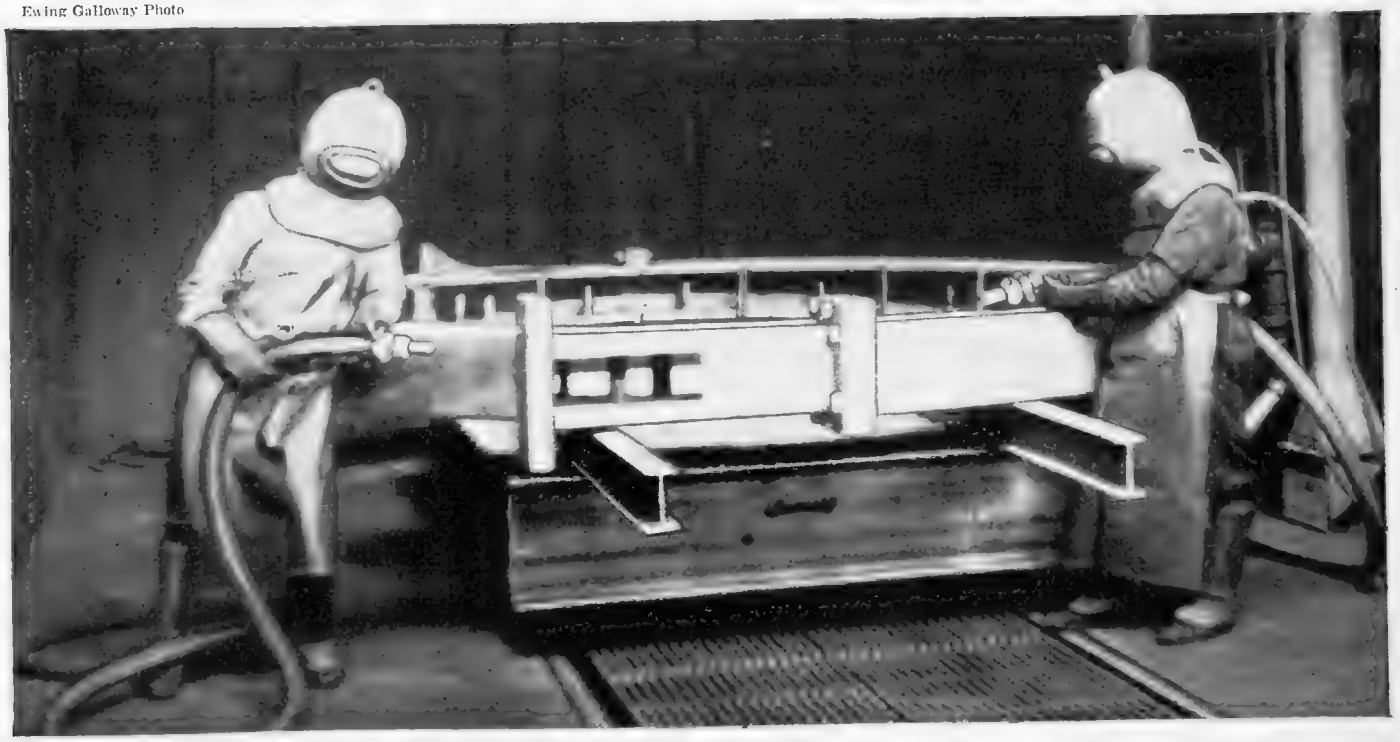
Shall I change my occupation? By all means! If your occupation is unhealthy, it needs remaking according to hygienic standards. If you are a (*Continued on page* 350)



Finishing off a tennis court by means of a patent preparation which gives off a deadly gas. The workman is protected by a mask and glove. Left—When the operator of this punch press depresses the foot lever which releases the stamp, the cable attached to her wrist draws her hand back, thus preventing its accidental mutilation.

Divers' helmets protect these sand blasters from inhaling irritating particles while they clean steel machinery.

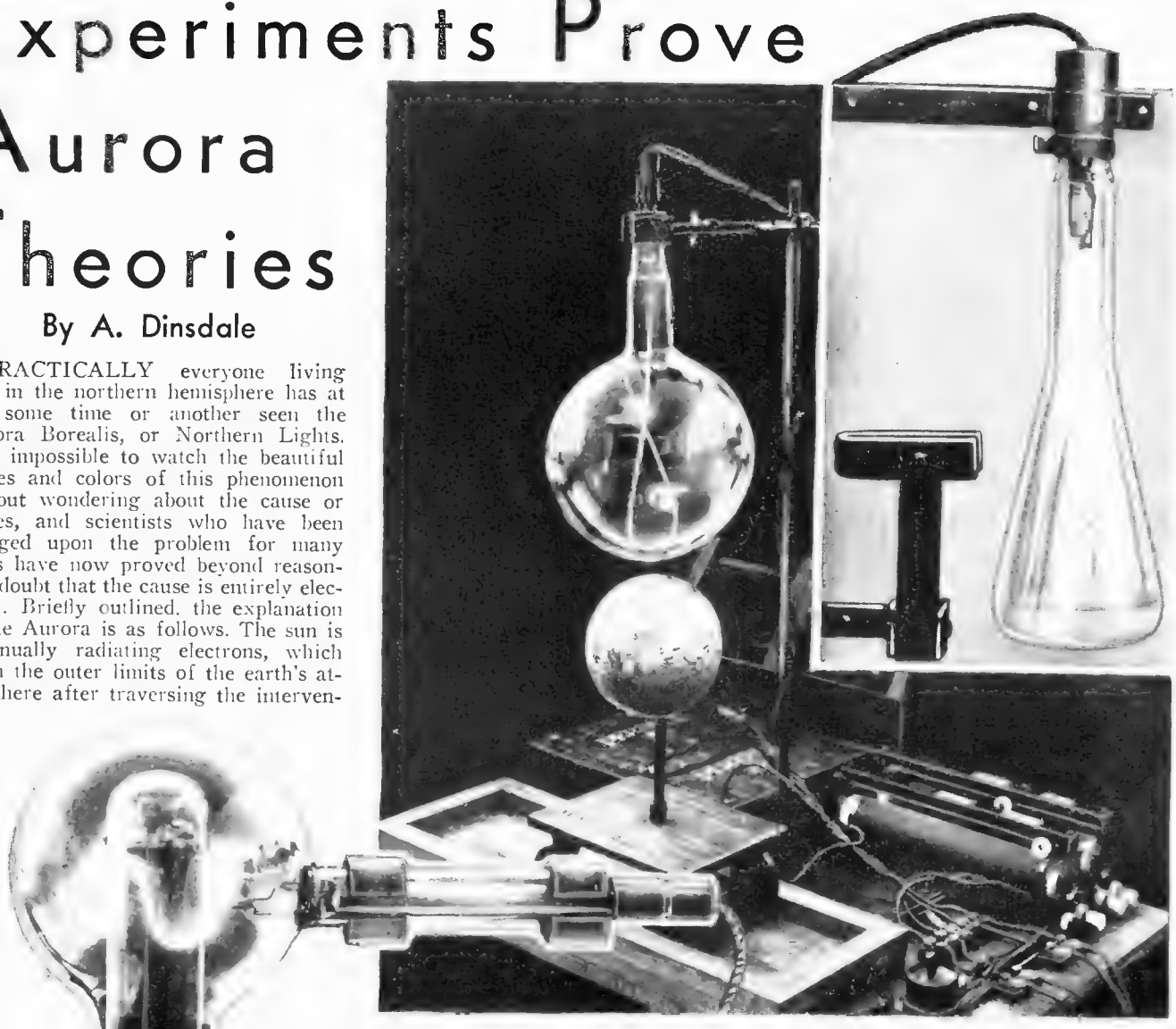
Ewing Galloway Photo



Experiments Prove Aurora Theories

By A. Dinsdale

PRACTICALLY everyone living in the northern hemisphere has at some time or another seen the Aurora Borealis, or Northern Lights. It is impossible to watch the beautiful shapes and colors of this phenomenon without wondering about the cause or causes, and scientists who have been engaged upon the problem for many years have now proved beyond reasonable doubt that the cause is entirely electrical. Briefly outlined, the explanation of the Aurora is as follows. The sun is continually radiating electrons, which reach the outer limits of the earth's atmosphere after traversing the intervening vacuum—just as the electrons emitted from the filament of a radio tube traverse the vacuum and reach the plate. But when these electrons reach the beginnings of our atmosphere, 300 or 400 miles above the earth, the flying electrons collide with atoms of gas, producing ionization (electrification) of the gaseous layers (Heaviside Layer). Each collision also produces a flash of light, just as in exactly similar circumstances light is produced in Geissler, neon, or other gas discharge tubes.

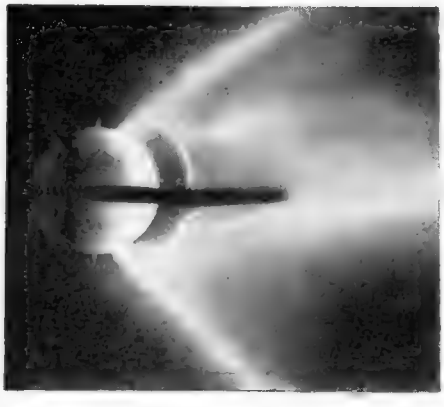


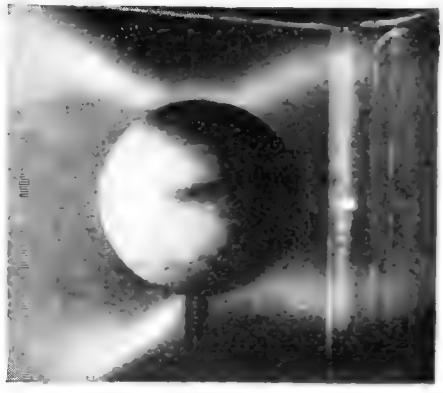
Experimental demonstration of the manner in which an electron stream approaches a pole of the magnetized earth. The electrons are deflected away from the pole. Upper right inset—A cathode ray tube for producing an electron stream. The magnet at left deflects the electron stream. Left—Experimental demonstration of the periodic path of electrons round the equator.

This theory was first propounded by Birkeland in 1896, and by 1904 the Norwegian scientist, Störmer, had worked out the theory on a mathematical basis.

There remains to be explained the peculiar shapes which the Aurora takes. These are caused by the influence which the earth's magnetic field has on the streams of electrons. It is well known that a stream of electrons, in the form of a cathode ray, for example, can be bent aside from its straight path by means of a magnetic field. It is possible also to cause a stream of electrons to spiral around a line of magnetic force. The most important of all paths which exist in the magnetic field of a magnetic element is the circular path which in the equatorial plane is concentric with the equator. With reference to our earth, it is further removed than the orbit of the moon. Exactly in the middle space between it and the earth is the frontier of an unelectrified region which surrounds the earth like a pad. From above and below, the electrons approach the polar region of the earth on complicated paths. Going down through the atmosphere the rays which originally had cir-

(*Continued on page* 346)



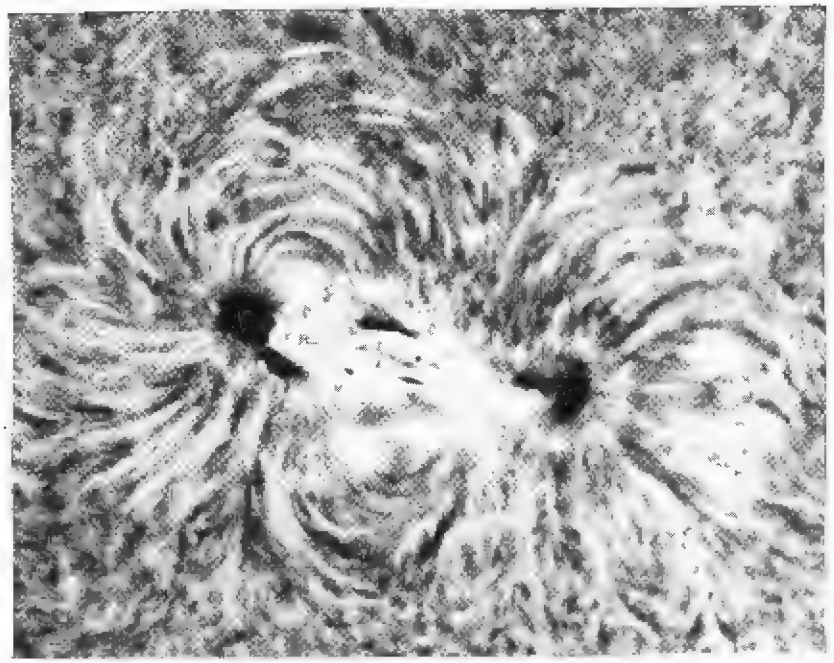


Left—Showing the influence of a circular current on the point of impact of the electrons. Right—Polar light experimental model used by Birkeland.

Whirlwinds on the Sun

These Gigantic Whirlwinds, Counterparts of Terrestrial Tornadoes, Prove That the Sun's Surface Is in a Violent State of Tumult. They Are So Huge That a Body the Size of the Earth Would Be Swallowed Up and Lost Inside One of Them

By Donald H. Menzel, Ph.D.
Lick Observatory, Mt. Hamilton, California



Sun-spots frequently occur in pairs, each member rotating in an opposite direction. The curved penumbra shows the cyclonic motion.

THROUGH our telescopes we can see that the surface of the sun is in a state of violent agitation. The fiery gases seethe and whirl continuously. Occasionally the tumult becomes so great that jets of matter, like spray from a gigantic wave breaking upon a rock-bound coast, are tossed thousands of miles out into space. In the hot solar atmosphere we find the counterparts of terrestrial tornadoes, but on so large a scale that a body the size of our earth would be lost inside the limits of the whirlwind. Storms! Within an atmosphere where the gases are at a temperature of 6000° centigrade (11,000° F.)! Where 50,000-mile-an-hour gales are frequent and where 100-mile-an-hour winds constitute stagnation! No wonder, the sun is so interesting an object for astronomical study.

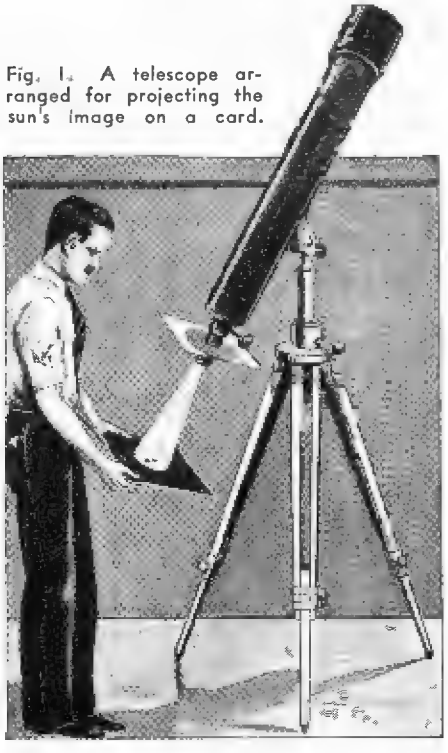


Fig. 1. A telescope arranged for projecting the sun's image on a card.

Aristotle taught that the sun was composed of virgin fire, a theory apparently so in keeping with the sun's rôle as ruler of the day and giver of life, that belief in the purity of the sun became a fundamental ecclesiastical doctrine. Therefore, when Galileo, in 1609, turned his newly invented telescope upon the sun's shining disk and found it to possess numerous dark spots, his announcement of the discovery brought him into great disfavor with the church. The sun, being of pure fire, could not possibly possess spots! The spots seen by Galileo, if not motes in his own eye, were probably merely birds!

Patiently Galileo met the objections. He showed that the motions of the spots across the solar surface did not in the least resemble the erratic flying of birds. He also proved that the objects could not possibly be in the earth's atmosphere. Then, his antagonists averred, perhaps the markings were hitherto undiscovered planets, whose dark disks were projected against the sun's. Galileo replied that the spots frequently changed size and shape, and that their rates of motion were in accord with their being actually a part of the sun. The well meaning but bigoted prelates, confuted by their own arguments, had no recourse but to pronounce the telescope an invention of the devil and to warn the laity against looking through it lest they,

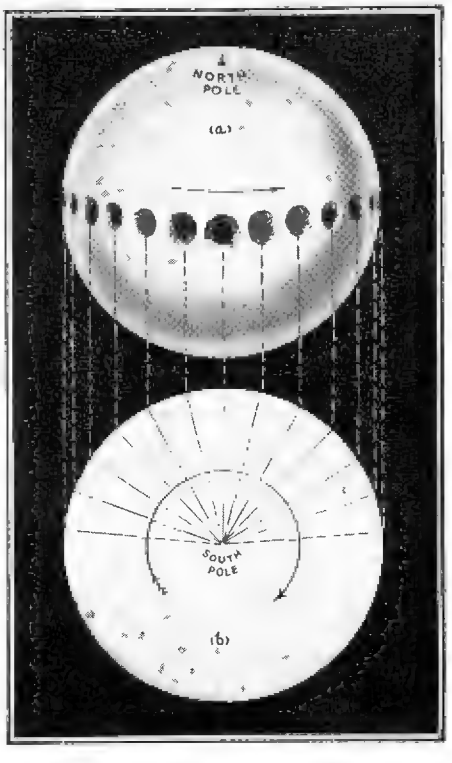


Fig. 2 (right). Solar rotation shown by position of spots on successive days. The spots are depressions in the sun's surface.

Courtesy U. S. Dept. of Agriculture

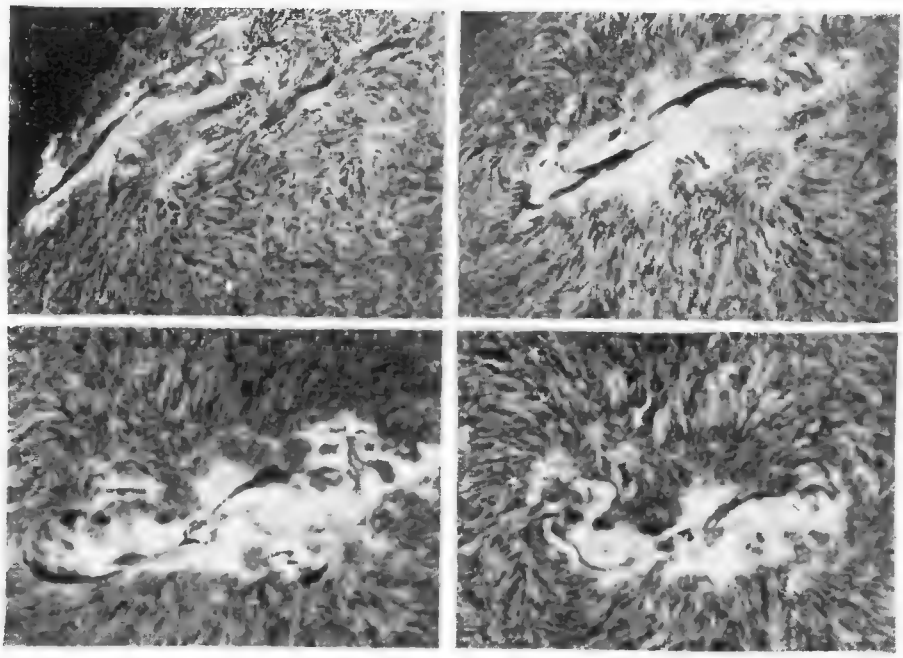
Here is a tornado cloud, the earthly analogue of the sun-spot. Below—Four views of a sun-spot taken at two-day intervals. Note the trace of ejected matter extending above the spot in the upper left-hand photo.

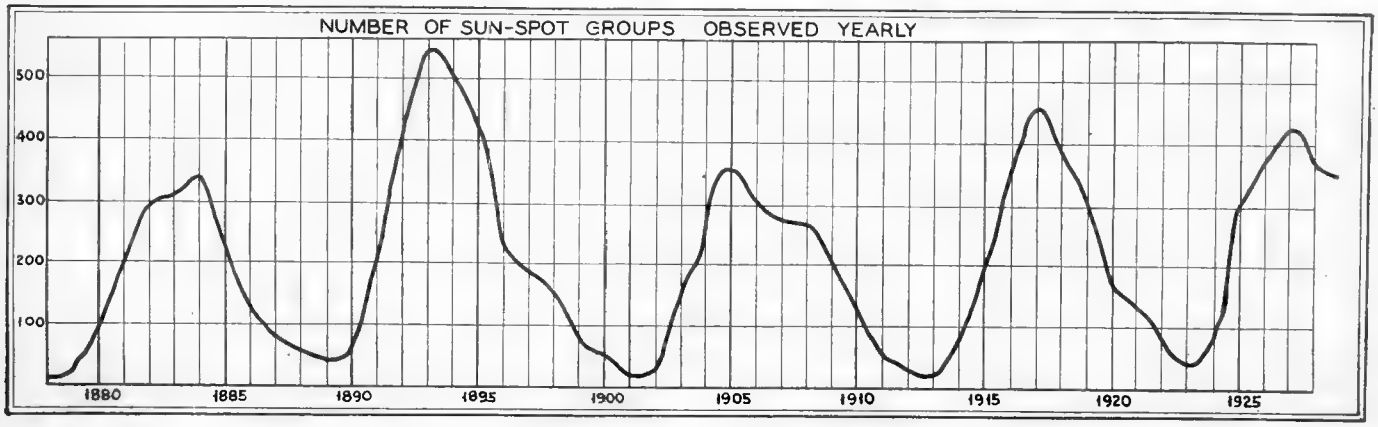
too, should become bewitched and see sights that common sense told them could not be real. But ecclesiastical ban could not long prevail against the "witchery" of science, and the solar nature of the spots eventually was established.

See the sun-spots for yourself! No elaborate equipment is required. Field glasses, a small pocket telescope, even opera glasses will suffice to show the larger ones. To protect the eyes from the blazing sunlight, a piece of smoked glass, or a fogged photographic plate should be mounted in front of the objective lenses. For large instruments it is more practical to mount the dark glass in back of the eyepiece. With a little persistence, even with such modest instruments as these, anyone can perform several very instructive observations. It is interesting as well as amusing to keep a daily record of sun-spots. This may be done by drawing a circle to represent the sun and sketching in the spots free-hand. A more accurate chart can be made by mounting the telescope as shown in Fig. 1. No dark glass is used in this arrangement. The eyepiece is pulled out an eighth of an inch or so beyond its customary focus and a piece of cardboard placed about a foot behind the end of the tube receives an image of the sun. The best focus is determined by adjusting both the eyepiece and the distance of the card from the telescope. The farther the card from the instrument, the larger will be the solar disk. The purpose of the card mounted on the tube is to throw the other card into shadow, so that the details of the solar surface can be studied.

Almost immediately it will become apparent that the sun is rotating about an axis. A composite drawing made from a series of diagrams is given in Fig. 2a. It shows successive positions of the same spot at intervals of one day. The apparently more rapid motion near the center of the disk is an effect of perspective. The spot actually is moving uniformly, as shown in Fig. 2b which is drawn looking down upon the sun's south pole. From the fact that it takes about thirteen and a half days for a spot to cross from one side of the disk to the other, we conclude that the sun's rotation period is twenty-seven days. When corrections for the motion of the earth are introduced, the true rotation period* comes out about 24.65 days. This figure is for a spot exactly on the solar equator. If our spot had been at latitude 30°, it would have taken fully a day longer to make its circuit, while if it had been at 45° almost two days longer would have been required. The sun evidently does not turn like a solid body. If, as (*Continued on page* 330)

*The period we would obtain if the earth were stationary. In the elapsed four weeks, the earth completes about one-thirteenth of a revolution. Hence, the observed period is about one-thirteenth too long.





Plants That Act Like Humans

Not Such a Preposterous Idea Either, as You Will Undoubtedly Agree When You Have Read This Fascinating Article

By S. Leonard Bastin

CAN plants think? Can they feel like human beings? Can they express themselves? Are they capable of offensive and defensive action as we are?

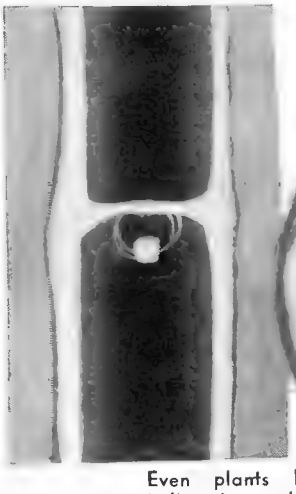
These and a dozen other questions must inevitably occur to anyone who has spent a great deal of time in the close study of plant life. In preparing this article I have selected just a few of Nature's curiosities of the plant world.

Mexico is a land of strange plants, which are curious because they have had to adapt themselves to the climate in which they live. Much of Mexico is semi-desert region, where rain only falls at rare intervals and the vegetation is largely of a succulent nature. Cacti, agaves and aloes abound.

One agave which always attracts attention is known as "the plant which turns its back to the wind." This plant grows in desert regions where, at certain seasons of the year, a hot, dry and extremely strong wind blows. The wind gathers clouds of sand with it, and this sand would so collect in the cavities between the leaves of the agave that the plant would be absolutely choked. The plant has surmounted this difficult problem of self-defense by the simple expedient of always turning its back to the quarter from which the wind blows. As can be seen from the accompanying photograph, the heart of the agave is completely sheltered by the clustering leaves, and no sand can work its way into the interior.

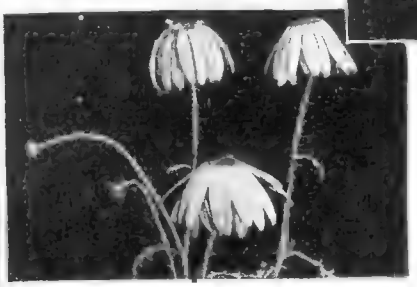
The handsome yucca, which depends for its existence upon co-operation with a tiny moth.

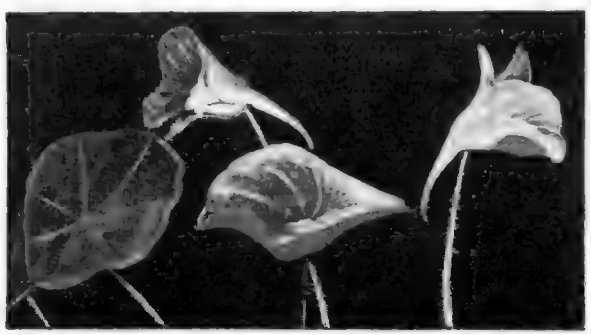
Few people realize that the handsome yuccas depend for their very existence on certain little white moths belonging to the genus *Pronuba*. During the daytime these moths, either singly or in pairs, can be found resting with folded wings within the half-closed flowers. After sunset they are to be seen flitting about from plant to plant and from flower to flower. This is the male insect, for the female is busily at work most of the time inside the flowers. Indeed, she has very little time for any aimless flying around. She has to carry out the duty of continuing her race, and she must also act as foster mother to the plant in order to secure a proper supply of food for her grubs which feed on yucca seeds.



"The plant which turns its back to the wind," a Mexican agave.

Even plants have indigestion and, like pearl oysters, produce a very hard, stony substance. Growers of bamboos, when they split canes, frequently find these stones deposited at the joints. Similar stones may be found in coconuts.





Humans and animals are not alone in their unpleasant reaction to rough seas. The photograph, upper right, was taken of some marguerites on a liner during calm weather, and the second picture of the same flowers, taken during rough weather, suggests that they are seasick. Left—Some flowers, like the nasturtiums shown here, become luminous at night some hours ahead of a thunderstorm.

The female moth becomes very active soon after dark, and she at first busies herself collecting a lot of pollen. She may be seen running to the top of one of the stamens, hard at work scraping the pollen grains towards the organs about her mouth. After gathering a sufficient supply, and shaping this into a ball about three times as big as her own head, she sets off for another flower.

On entering the new flower the moth plunges her lance-

(*Continued on page* 342)

A pearl shell, showing location of pearl.

Pearls—The an Oyster's

The Author of This Article Recently Completed an Investigation of the Pearl-Fishing Industry in the Dutch East Indies, and Tells a Fascinating Story of the Way in Which Pearls Are Formed and Found. Although Pearls Represent Good Luck to the Human Finder, They Are, According to the Author, the Product of the Oyster's Hard Luck

STENCH and Pearls. Who would ever associate that coveted treasure which graces milady's neck with a putrefying odor? Unfortunately the association exists. No more disgusting spectacle can be imagined than that of a crowd of natives employed upon the loathsome work of digging for pearls, with their arms buried into a hideous mass of corruption and filthiness, amid a horrible, putrid stench.

These thoughts raged through my mind as the small steamer that was plying between the Molucca and Arue islands off the coast of Dutch New Guinea, took me back, after a fortnight's stay with the pearl fishing fleet, to more civilized and less odorous realms.

I had been an interested visitor on an investigating mission of the pearl fisheries off these islands, my work being concerned with the development and peculiar habits of this most valuable of all molluscs. I also endeavored to get a glimpse into the life history and natural habits of the mother-of-a-pearl shell, the *Margaritifera* species, the leading variety found throughout the Australian, Polynesian and Far Eastern waters.

The pearling season takes place in the West Moesson, or West Wind Season, because at other times of the year the waters are too turbulent. The boat on which I was the highly interested passenger was of the lugger type, manned with eight brawny Manilarese (the divers par excellence) and supplemented by a number of Japanese. The fleet consisted of strong lugger-rigged craft, averaging some ten tons burden, assisted by cutters of large size which served as purveyors to our luggers, and also to bring the collected shell back to port.

The crew consisted of the divers, of which the headman took command, also acting as the sailing master. We had one tender, who also held the life line, attending to all signals from the divers while at work. There were some four or five working hands, who in pairs would take alternate shifts at the manual pumping apparatus for supplying the air to those divers who were supplied with diving suits.

A group of native pearl divers returning to the surface. Right—Nose clip worn by the native divers.

While diving generally takes place in a rather primitive fashion, without the use of elaborate preliminaries, so customary on the better equipped expeditions, in our particular case we had both types of operation, one in which the divers went down naked and another in which the most up-to-date diving apparatus was used.

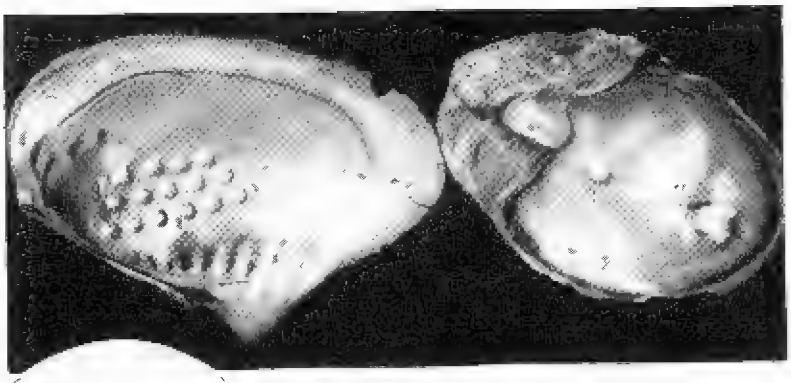
In cases where no diving suits are used, the divers go down stark naked, with greased bodies, greased cotton in their ears, a forked stick or tortoise shell clip upon their nostrils to compress them, and with a wide wicker basket or net attached to the waist.

Right—The author coming up from his dive to the oyster beds, which he describes in the text.

Bane of Existence

By Hendrick de Leeuw

Member, Royal Geographic and Batavia Society



Japanese culture pearls are shown in the left-hand shell, and a natural pearl in the right-hand shell. The latter are much more valuable.

On the signal from the main lugger, down they go. When about to plunge the diver seizes, with the toes of his right foot, a rope to which a stone is attached, taking hold of the work bag with his left (it being customary with the natives to use both hands and toes), and with their nostrils shut tight, go overboard. Getting to the bottom, they relinquish the stone and with dexterity and dispatch, collect as many oysters as their basket will hold. The stone used to accelerate the descent of the divers is usually a reddish granite, pyramidical in shape, round at bottom and top and with a hole in its smaller end sufficiently large to admit the rope. The men work at a depth of some sixty feet, and remain in the water from sixty to eighty seconds at a time. When they have filled their crates or nets, they appear fully exhausted on the surface to be hauled into the boat.

Since diving, as one can well imagine, is not without its dangers, the men are provided with either an iron spear or a short knife, which they carry between their teeth to ward off sharks or any other denizens of the deep. Of all these the ground shark is the most dreaded, and to show how this creature was feared, none of the divers will descend after an alarm has been given. Sharks in these waters are fairly common; still, the more experienced divers do not fear them as much as I expected at first, as it seemed that these demons are easily scared away.

When the oyster-laden fishing boats return, the catch is carried up the beach in sacks, as shown at left. The oysters are then stacked in heaps and left to rot for a week, when they are washed and opened and the pearls picked out, as shown above.

Mortality among the divers is not great. Pneumonia is the greatest scourge, while fatalities in the actual diving are very few. I observed that only the most robust men are selected, and was told that only these fellows can work below a depth of forty feet; beyond this depth, few can work without experiencing some detrimental effects. Diving itself, however, seems to create havoc, and while it affects each man differently, on the whole it proves to be injurious to health and if persisted in, it produces deafness and even paralysis.

Notwithstanding all these dangers, it is really remarkable to watch these fellows go down apparently totally oblivious of any danger that may lurk beneath. Each of the boats has a snake charmer, medicine man or conjurer. On the beach we found additional medicine men, chanting incantations or numbling secret formulae that were intended to drive evil spirits away, while the men on our boat threw sacrificial sticks and dozens of plates into the water. Without these elaborate preparations no diver dares to go down.

Having determined to investigate the habitat of the oyster shell, and the conditions under which it thrives, I induced the captain of the fleet to allow me to don a suit and go down on my own diving expedition. It took me fully twenty minutes to get into my diving suit, and as soon as the breathing tubes were tested, the lead weighted rope ladder adjusted, and the additional security of a life line fastened round my waist, I commenced my descent.

My first sensation was weird in the extreme, and similar to the unexpected and rapid dropping of an elevator from the top of a very high building. To be more exact, I could have sworn that some powerful force was trying to push my feet up through my body and draw them out at the top of my head. At first my head began to buzz and sing, and at times I felt as if it would split open. I began to wonder what would happen if it did. Then I began thinking in a more friendly strain of the odoriferous friends that I had left on the lugger, and I decided that after all an oyster bed was really no place for me in particular, or man in general.

As I got lower, the feeling of pressure from below seemed to change places and get on top, as well as completely surround me. I resolved not to be discouraged, and that even if I got flattened out to a wheat cake or exploded, I would go as far as the bottom of the lagoon, fill my crate and return to the surface. So I gritted my teeth and determined to stick it out, no matter what happened. I admit, though, that I preferred at that moment the company of dead to that of live oysters.

When I finally arrived at the bottom, I could not keep my feet down without crouching and bending my knees. The moment I stood erect, first one leg, then another, and finally both would flutter up the bed and wave aimlessly about like the limbs of a marionette. I lost control completely. I switched on the electric light and began to look around, and (*Continued on page* 340)

Big teams and lang whips with a flow of language that would scarch a mule's hide at fifty feet were part of the essential equipment in pre-tractar combining days of the old west.

An Idea That Grew Into an Industry

The Development of the Caterpillar Tractor Led to the Expansion of Agriculture, Revolutionized Many Industries, and Helped to Decide the War

By Alfred M. Caddell

THE idea is the thing—the initial "flash" of a picture that comes to mind. Sometimes this flash appears unheralded; sometimes it is the answer to a costly, baffling problem.

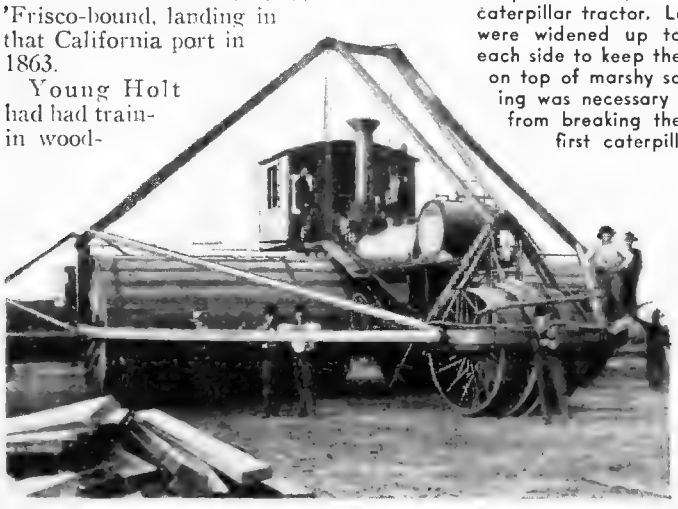
Here was the problem in this case: The early settlers in the San Joaquin and Sacramento Valleys, California—men who originally had trekked West in search of gold—found that the land yielded wonderful crops of grain. But, among other things, there was a great shortage of man-power to harvest the crops. Horses and mules were costly and failed to satisfy the demand.

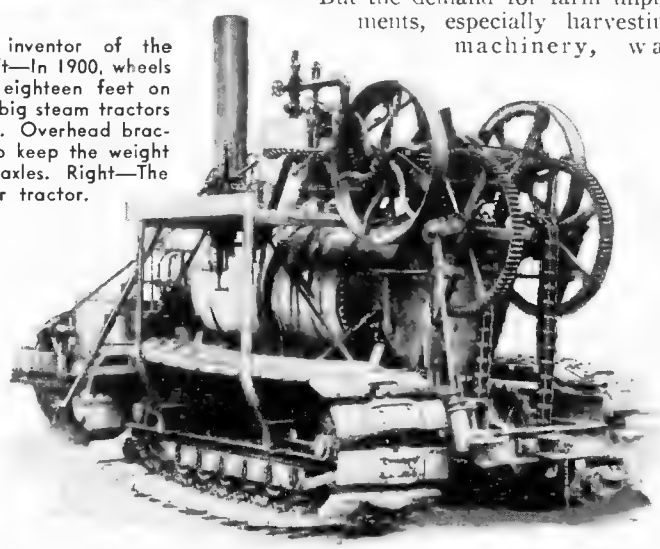
Young men from the Eastern states were of course among the pioneers. They traveled mainly on the wave of enthusiasm, not realizing what fate might have in store for them in the land of the setting sun. Among them was Charles H. Holt from the hills of New Hampshire, who shipped from Boston to the Isthmus of Panama, 'Frisco-bound, landing in that California port in 1863.

Young Holt had had training in wood-working, for his father owned a sawmill in New Hampshire. It did not take him long to establish himself in the brisk commerce of the San Francisco port, and by 1868 he had acquired sufficient capital to found the Holt Company, importers of hardwood lumber and subsequently of wagon material, for in those days all freight and passenger transportation was by wagon and stage coach. That led to a constantly growing demand for vehicles and such like, and presently the pioneering Holt and two of his brothers established a wheel factory at Stockton, California. Subsequently a younger brother, Benjamin Holt, who afterward was to invent the caterpillar tractor, was brought from his father's sawmill in New Hampshire to direct the new factory.

Benjamin Holt, the inventor of the caterpillar tractor. Left—In 1900, wheels were widened up to eighteen feet on each side to keep the big steam tractors on top of marshy soil. Overhead bracing was necessary to keep the weight from breaking the axles. Right—The first caterpillar tractor.

But the demand for farm implements, especially harvesting machinery, was





equally insistent, and the Holts branched out into the manufacture of them, too. Also it seemed that the cry for power, other than horse or mule power, could never be satisfied. Wonderful valleys of rich peat soil, a wonderful climate for the growing of grains, a wonderful market for such products in the Orient with ships waiting in the 'Frisco and Oakland ports—but still something lacking to complete the picture of prosperity.

Other manufacturers besides the Holts had worked hard to produce the combined harvesters and threshers that seemed so admirably suited to the fertile plains of California. Enormous machines, requiring the power of thirty-two mules to draw, were developed. But assembling thirty-two mules to work efficiently as one power unit proved to be a problem in itself, and the only answer at that time, was steam power.

So the manufacturers tackled that problem, among them, of course, the Holts, and they produced the wheel-type tractors so familiar to the Dakota plains. But if serious objection had been found in the working of thirty-two mules as a unit, equally serious faults were to be found in the employment of tractors. For the delta lands were soft and apparently bottomless, and the huge machines, weighing from ten to twenty tons, not only packed the earth so that it subsequently baked and injured the seed bed, but they mired down and became absolutely useless.

Wider wheels for better distribution of the weight would solve the problem, the farmers said, and the manufacturers produced wider wheels. From two feet wide they grew to six feet, to twelve, to eighteen! Monstrous spool-like wheels, fitted on each side of the tractor, made the machine nearly fifty feet wide in all.

But still the problem remained unsolved, for wider wheels, with their attendant overhead bracing to more equally distribute the axle load, meant proportionately more weight—not less—and the handling became most difficult and in many cases totally impossible.

For years Benjamin Holt concentrated on this problem. Extreme width of wheels had proven to be no good, and as for great diameter, so that larger areas of the wheels would rest upon the ground, that seemed to be out of the question too, for Holt had calculated that wheels eighty feet high would be required to provide the necessary bearing surface on the soft ground! But then, even with a fabricated type of wheel, the weight would be enormous, as would also be the power necessary to drive it. And weight was the bugaboo of tractors on that soil.

If there was ever a situation that seemed ripe for the coming of an invention here it most certainly was. Briefly, Holt concluded, it all resolved itself into a matter of bearing surface and traction. Power and everything else there was in plenty, but practical weight distribution? That was the problem.

Among inventors it is well known that if they "sleep on a problem" long enough—that is, turn it over and over in their minds—an idea that will solve that problem is liable to present itself. And it proved to be no different in this case.

"Do you remember grandfather's treadmill?" Benjamin Holt asked Pliny E. Holt, his nephew and engineer, one day.

"Yes," the younger man answered.

"I believe that treadmills built under the combined harvesters and traction engines would bear them up in the soft soil just like platforms," he went on. "Power could be applied to operate these treadmills by applying it through sprocket wheels and forcing the tread around instead of the tread, as worked by a horse, causing the sprockets to turn. Thus the treads, with their cleats, would serve as endless tracks and would bear up an enormous load very lightly—that is, the weight would be very evenly and lightly distributed."

"Let's try it," suggested the younger man.

A momentous discussion, this, one evening in 1904. Details of the design were threshed out in a conversation that lasted until midnight. The idea had been born and the next day found them at work.

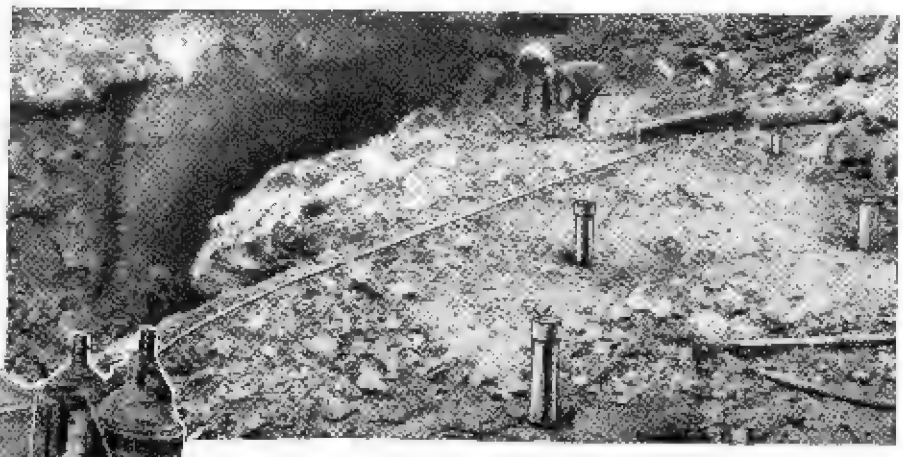
Previously the Holts had incorporated the link belt idea in their combined harvesters and threshers. Instead of applying the power of the engine to the various pulleys to be worked *via* gearing and shafts, they did it with the link or chain belt. This was one of the features which had made their combines a success, and they capitalized on the link belt to serve as their first endless tread.

Two malleable belts were obtained from the harvester works, and to these were attached hardwood blocks at regular intervals to serve as treads. The drive wheels of a tractor were removed and the platform wheels thus hastily constructed were attached over big drive sprockets and idlers. Not all in one day, however, for the work was necessarily of an experimental nature, but the machine was ready for trial in January, 1905.

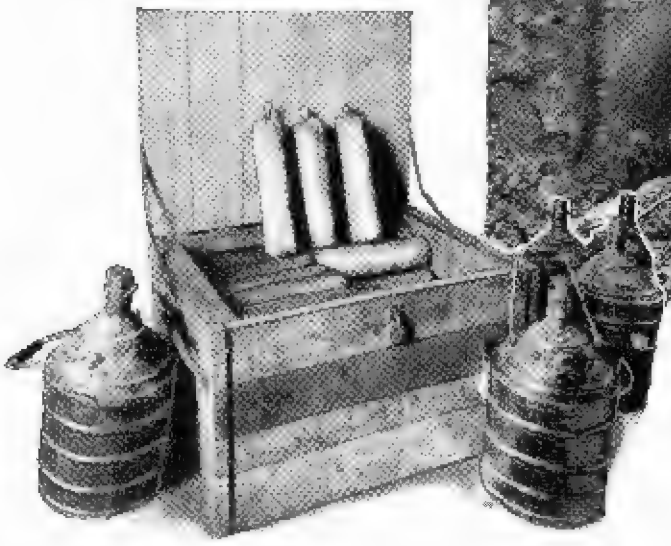
On the morning of the trial it was with high hope and confidence that the inventor and his assistants watched the firing of

(*Cont'd on page* 332)

Modern caterpillar tractors, such as the Caterpillar Fifteen shown at top, find many uses on the farm. They can go anywhere, and climb practically any gradient. One of the tractor's many uses is illustrated at the right, where one of them is shown in use clearing land preparatory to building a giant levee. Center picture shows a British war tank, with caterpillar treads, negotiating rough ground.



Placing liquid oxygen cartridges in drilled holes for blasting calcite rock. Cartridges are made of cheese cloth bags, filled with powdered carbon, then soaked with liquid oxygen.



Here are the bags of carbon used instead of powder or dynamite for blasting. They are placed in a copper-lined wooden box where liquid oxygen is poured over them.

Oxidation—

By Alfred

Professor of Shop Practice, Stevens Institute of Technology;

BACK in the early beginning of metal implements, up to today's noisy call from the tools of the structural steel daredevils, man has fought to overcome the power of one of nature's most effective laws—oxidation! No sooner was iron extracted from its ore than oxidation began to attack it, and send it back to earth principally as a hydrated metallic oxide. The action is sometimes so slow that it takes centuries to accomplish. Or it may move so quickly that it can hardly be controlled.

That the oxidation of iron was and still is to be reckoned with may be appreciated from estimates which go to show that oxidation (rusting) causes a loss of steel in the United States of about $300,000.000 per year, and $900,000,000 per year in the whole world. As the word *rust* indicates *red*, it seems hardly proper to speak of the green corrosion of a copper roof, nor of the dark tarnish on brass, as rust.

Oxidation of iron or steel in the form of rust is the result of the combining of oxygen with the metal, accelerated by moisture. When man turns in another direction, it is but again to meet oxidation, not as *rust* produced at a heatless temperature, but as fire from the *burning* of combustible material. Even finely divided iron will burn if thrown into a candle flame.

Perhaps it was this very destructive power of oxidation which caused man to try to turn it in a worthwhile direction. This power of oxidation is now called upon to cut irons and steels which is done at a high temperature and with commercially pure oxygen gas.

Thus there came about a modern wonder-tool—the oxyacetylene cutting torch. It is not a complicated mechanism and quite simple to control. The torch has three tubes, one for a low pressure fuel gas, acetylene, another for low pressure oxygen, and the third for high pressure oxygen.

By the combination of the low pressure oxygen and acetylene a flame is produced with which a red hot spot can be made on a piece of iron or steel. Then the high pressure oxygen trigger-valve is snapped open, and oxidation occurs at so rapid a rate that a groove is made through steel in a few *minutes*. A power-cutting machine would require several *hours* to do this. The process is called *gas cutting*, and the principle involved is that of the oxidation (or *burning*) of the iron. This oxide is readily fusible. As fast as produced it melts and flows away from the cut, like water and the cutting goes on with astonishing rapidity. Here is practically perfect control of the same natural force, oxidation which has proved so destructive in producing undesired *rust*.

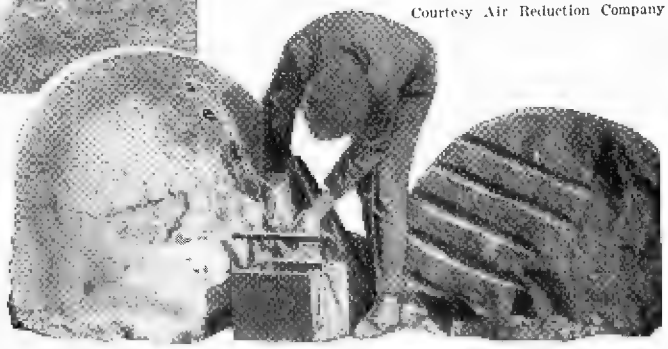
Cutting through a piece of steel six inches thick, in the Engineering Shops of the Stevens Institute of Technology.

To some it may be a bit surprising to learn that iron and steel can be burned to an ash, and that the path of burning may be accurately directed. And probably the interest will be intensified when it is known that this harnessed, oxidizing stream of gas can burn its way by forming a groove, a *kerf*, from 1/64 to ¼ inch wide, not only through a thin piece of steel, but through a thickness of more than five feet. It can pierce the ugliest looking blast furnace skull or salamander and reduce it to reclaimable size. It will operate under the waters of the sea as deep as the diver who carries it can reach, and will burn a way through the steel hull of a sunken ship. The torch will push on through metal, "frozen" in a tap-hole, to release the stream of molten steel waiting to be made into a shaft for a ship, rails for the railroad, big guns for the navy, and millions of machine parts. It submits readily to being guided by special machinery along lines straight or curved, to form small things, or maybe a big unforged side-rod of a locomotive. Fastened in the tool-post of a lathe it may be used as a fiery parting tool to sever a big revolving piece of steel, and do it in a tenth of the time required by a steel tool.

The efficient operation of the

Man Is Carrying on What Seems to Be a Never-Ending Battle Against One of Nature's Most Effective Laws—Oxidation. Oxyacetylene Cutting Torch and Oxygen Lance Make Commercial Use of This Destructive Natural Force, Thus Saving Millions of Dollars Yearly

Courtesy Air Reduction Company



A Wonder Tool

S. Kinsey

Member, American Society of Mechanical Engineers

Preparatory to blasting a skull, holes are burned into it with pure oxygen delivered by a ¼ inch gas pipe.

oxyacetylene cutting torch depends on the purity of its oxygen and the high combustibility of the acetylene. The oxygen is charged into steel cylinders containing 220 cubic feet at 2000 lb. per square inch. Its purity is guaranteed to be 99.5 per cent.

The fuel gas for the torch, acetylene, is made by the action of water on calcium carbide. Crushed coke and lime heated in an electric arc furnace, produce calcium carbide, CaC_2, which fuses and is run into molds to become solid. It is gray in color. A pound of it reacts with water producing about 4½ cubic feet of acetylene gas, C_2H_2, containing 92.3 per cent of carbon and 7.7 percent hydrogen. It is highly combustible and explosive, a powerful gas when rightly used. Acetylene contains 1685 British thermal units per cubic foot (gasoline about 70 B.T.U. per cubic foot of average mixture used in automobiles). When confined as a free gas, or especially when liquefied, it is liable to explode violently. It is stored in steel cylinders which are packed with infusorial earth, corn pith, or other porous fillers. Then acetone is poured into the cylinders and absorbed by the filler. The acetylene gas follows and is dissolved by the acetone, at the rate of 24 times its own volume at atmospheric temperature and pressure and the dissolving power of the acetone increases with the pressure an equal amount for each atmosphere (about 15 lb.) increase of pressure. When the pressure is reduced, in the opening of the valve on an acetylene cylinder, the dissolved acetylene becomes gas. In this way, it may be used without danger of explosion.

An acetylene cylinder contains the equivalent of about 240 cubic feet of gas at a pressure of about 250 lb. per square inch. When burned in an atmosphere of pure oxygen, as in the oxyacetylene torch, it will produce a temperature of about 6300 degrees Fahrenheit—next to the electric arc the hottest artificial heat production known.

Pure oxygen and acetylene make a strong team. Man has nature's powerful law of oxidation so thoroughly under control that the acetylene cutting torch becomes a wonder-tool even in the hands of the unskilled. It will cut ⅜ inch steel by free hand at a rate of 125 linear feet per hour. It will flick off the heads of ¾ inch rivets at a speed of 5 per minute. A 24-inch steel riser drops off in the foundry in about 15 minutes. It cuts up old cars and locomotive worn parts as reclaimable scrap in piles like small mountains, worth millions of dollars per year. With merely the change of its tip, the oxyacetylene torch can be applied to cut cast iron, full of carbon, and once difficult to be torch-cut. It will readily burn its way through old locomotive cylinders (once dumped in the swamps to sink out of the way), so that they are reduced to cupola-size, remeltable scrap. Old cast iron ship propellers are no longer thrown overboard.

Using the oxyacetylene torch to cut up old cars and locomotive parts. The scrap reclaimed yearly is worth millions.

This gas cutting torch has moved forward from a scrap reclaimer and repair tool to one of the automatic machine type for rapid production work. It can be guided to cut accurately in straight lines, or around curves, and to form practically all the shapes common to modern shop practice in steel, without the locked-up strains sometimes found in forgings.

One of the most striking examples of controlled rapid oxidation is to be found in the use of the *oxygen lance*, the queerest and simplest of the several forms of oxygen cutting torches. It is only a piece of ordinary ¼ inch gas pipe, from 10 to 20 feet long, connected by rubber hose to an oxygen cylinder. It is used much in steel mills for reclaiming skulls and salamanders. Now, in the melting and pouring of steel the last of the metal tapped from a furnace is likely to be a mixture of dirty steel and slag. This is allowed to become solid in the big ladle, and when

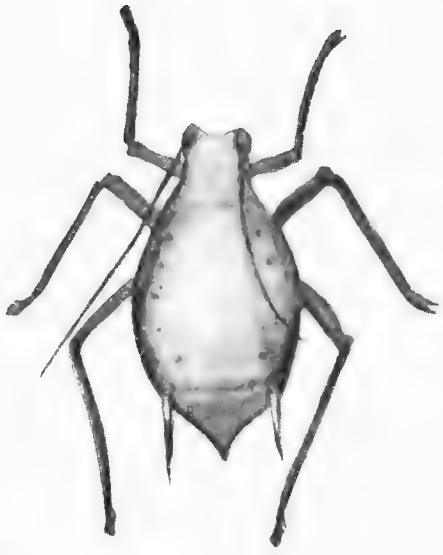
(*Continued on page* 329)

Phenomenal Developments in Micro-Photography

Micro-Photography Up to Two Hundred Diameters Is Not New, But the Method Described Here Whereby Depth of Focus Can Also Be Obtained Is a Revolutionary Advance

By J. G. Pratt

Scientific Photographer, U. S. Dept. of Agriculture

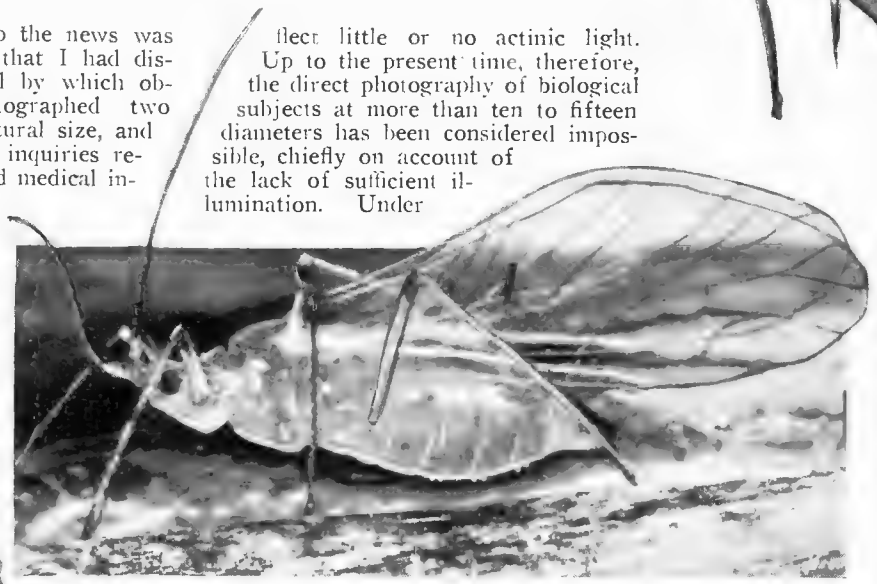


Above — Plant louse, magnified 50 times. left — Winged plant louse, magnified 25 times.

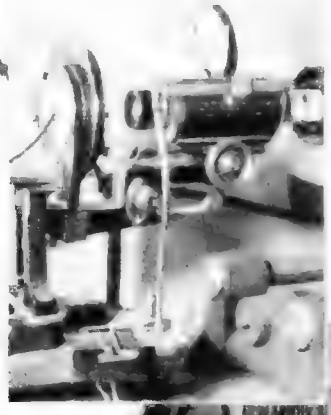
A FEW months ago the news was widely published that I had discovered a method by which objects could be photographed two hundred times their natural size, and in answer to the many inquiries received from colleges and medical institutes, I am giving a detailed account of how this work is accomplished.

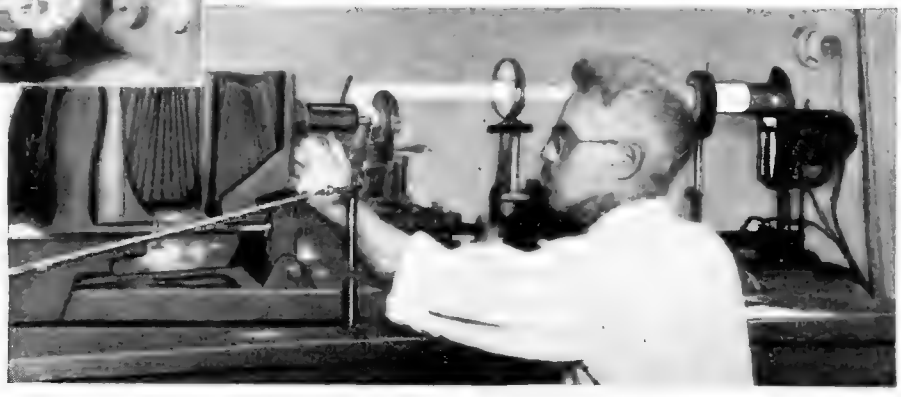
Insects and minute biological subjects of all kinds which are too small for their character to be discerned, cannot be photographed natural size and then enlarged, because all detail would be lost in the process of enlarging. For this purpose, therefore, we employ what is known as "micro-photography."

I have made rather wide investigations, and have found only one commercial high-power direct-lighting outfit on the market, and although that is reputed to be excellent for metallurgical studies, which are flat and reflect a great amount of light, it is of no value whatever for biological subjects, which have more or less depth and reflect little or no actinic light. Up to the present time, therefore, the direct photography of biological subjects at more than ten to fifteen diameters has been considered impossible, chiefly on account of the lack of sufficient illumination. Under ordinary conditions a natural size photograph would require about one second exposure, and as the exposures increase according to the square of the amount of magnification, five diameters would require 25 seconds; and at the same ratio 100 diameters would take between two and three hours—obviously impossible. A truck rattling over cobblestones a block away can cause sufficient earth tremors to show movement in a photograph even at ten diameters.



Above — Rice weevil, occurring in flour and other cereal, magnified 40 times. Right—Support and track for focusing concave mirror. Below, right—Mr. Pratt at work with his new camera. Note light path, explained in text.





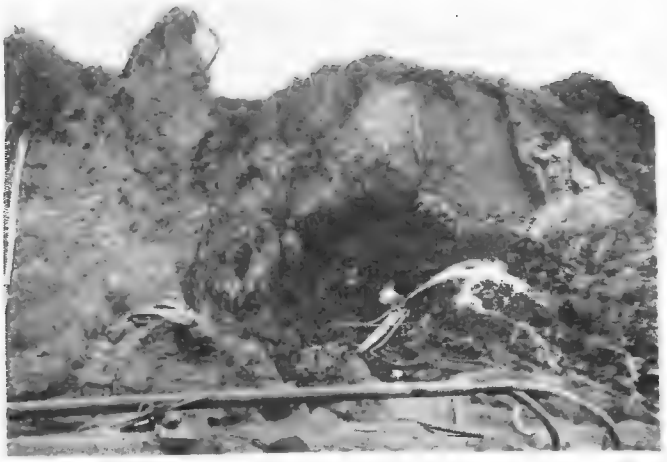
Another drawback has been the flatness of field or lack of sufficient depth of focus so that merely the top of the object would be clearly defined, the rest being hazy and distorted. In other words, the long-focus lenses (giving depth) could not be used on account of the impossible length of bellows draw required.

Both of these difficulties have been overcome, so that it is now possible to take these photographs with a few seconds exposure only, and by using certain combinations of lenses, to secure great depth of focus with only the usual bellows draw.

The machine which I have used is an adaptation of the standard photo-micrographic outfit, which is a part of the equipment of every biological and medical research laboratory, and the illumination is merely the rays from the arc, passing through the condenser into a concave mirror; from which it is reflected back upon the specimen to be photographed. The entire force of the arc, intensified by the condenser, is concentrated further by the mirror upon a spot about one-half inch in diameter; and to (*Continued on page* 334)

Washing Down Hills to Make New Land

By Edwin F. Lindenberger



High pressure water jets from monitor nozzles are driven against the hills and wash the soil into the gullies below.

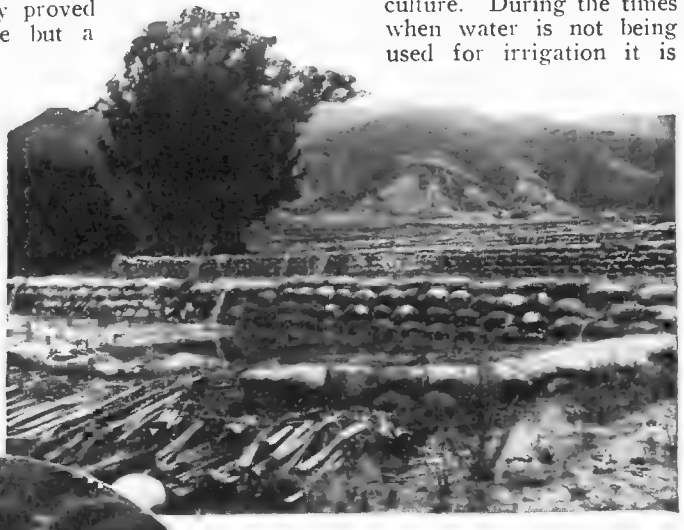
THE process of land erosion is proceeding steadily and relentlessly the world over. Coastlines are being altered by inroads of the sea, and hills and mountains are being steadily reduced in height and shape by rain, winds and fast-running mountain streams which carve out deep gullies. In most cases, this erosion is regarded as a curse, and frantic efforts are being made in some cases to stop it. But here is a Californian who has reversed the process and caused water to fill up gullies by washing down hills, thus making for himself new and fertile land for cultivation.

Hydraulic farming, they facetiously call it, is a unique program of sluicing down the hills in the East Highlands area of San Bernardino county, California. Canyons of the foothills are being filled to become new land for the growing of oranges. The locale has proved ideal in elevation, climate and prevailing temperatures for the purpose.

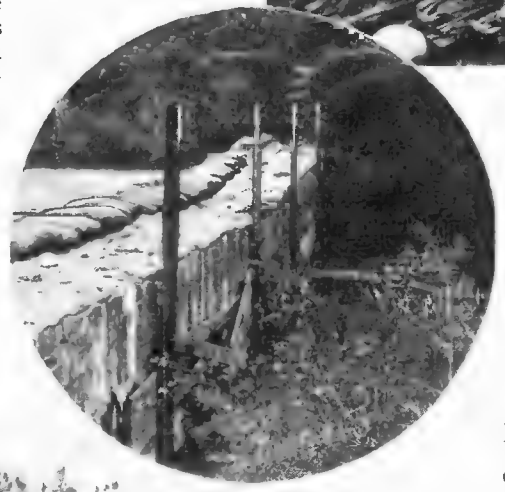
J. S. Edwards, owner of 1000 acres of orange and grapefruit groves on the western slope of San Bernardino mountains, developed the method of leveling land to reclaim otherwise worthless land. The hillsides of East Highlands were cut and slashed with great gullies, with a vantage point on the slopes here and there where some of the best citrus groves of Southern California were located.

Mr. Edwards secured the bare land fifty years ago when it was practically worthless. While much of it was put under cultivation and irrigation, these gashes through the property proved not only an eyesore but a positive additional expense for the ordinary agricultural practices.

Then was developed the system of filling canyons and building up the soil, said by engineers to be the only instance in the history of American agriculture. During the times when water is not being used for irrigation it is carried in pressure lines and shot into the hills above the canyons. Across the canyons at strategic narrows dirt-sack dams have been flung. Against these the muddy stream deposits its hill soil and the gully fills amazingly fast. The dams are raised each year until the canyons are level with orchards on each side, and then planted after grading and fertilization programs have been completed.



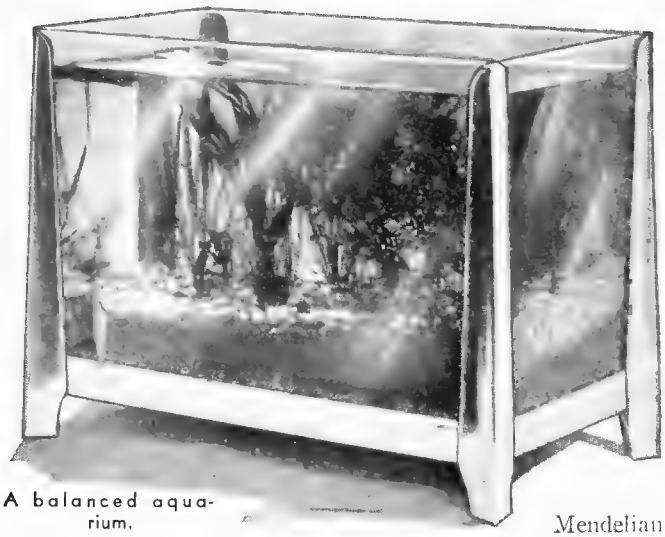
Right—This was originally a deep arroyo through the J. S. Edwards orange groves. A series of check dams was placed across the wash and mud rolled against them. Each year the dams were heightened until the gully was entirely filled. The sacks quickly rot away and the leveled canyon is then graded and planted.



Above — A fill in process of development. Each year a concrete dam is built up to the level of the sacks. Eventually the canyon floor will reach the top of the bank, 40 feet high, and make several acres of ideal citrus soil. Left—A few months ago this slope was a deep gorge. Although now nearly filled, mud is still being deposited.

The cost is much less than at first would have been thought possible. While, unfortunately, no records as to cost per cubic yard have been kept, it is proved that it costs no more to move soil a mile by this method than it does to pick it up with the ordinary tools of team or tractor.

The cost per acre, however, should be considered as an asset to the entire grove. Grant, as illustration, that one of these canyons was filled and an acre surface had resulted from expense of $1000. As citrus land the acre would be worth anywhere from $1500 to $3000. But, the improvement expense should be charged to the entire 1000 acres, for it has meant lessened overhead for irrigation, cultivation and labor.



A balanced aquarium.

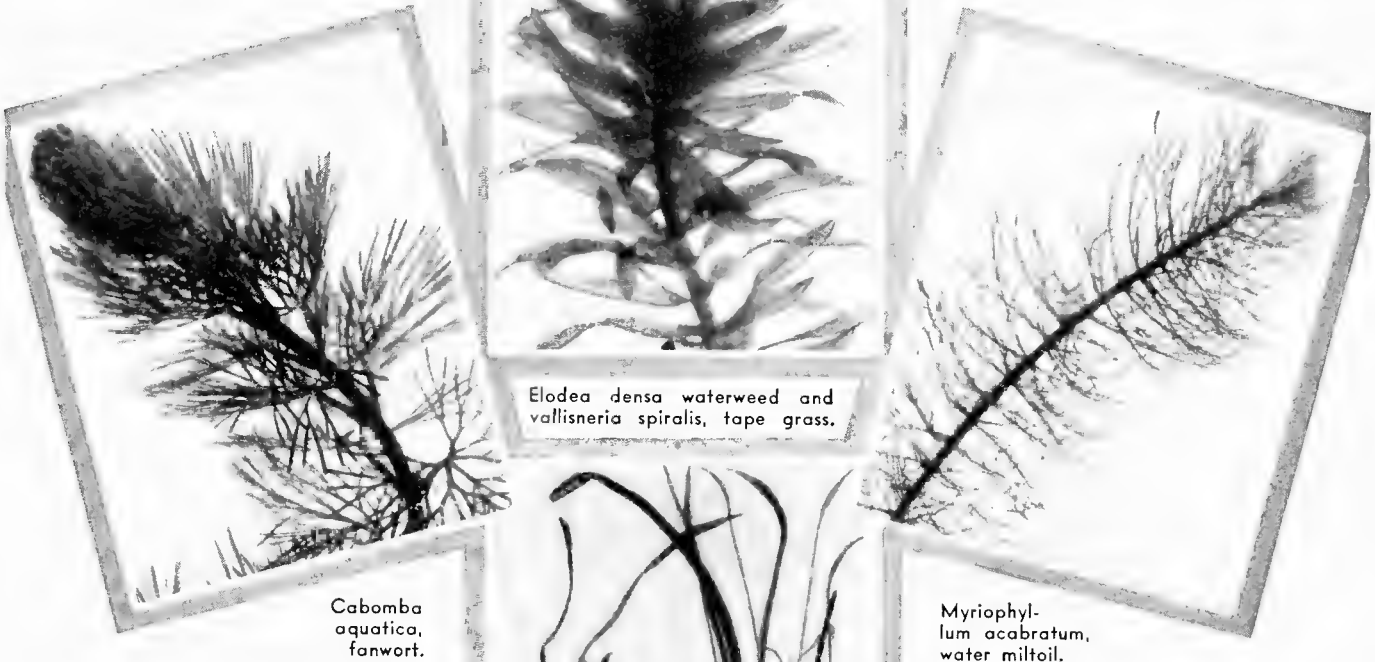
Raising Toy Fish for Profit

By Dr. E. Bade

RECENTLY a terrific impetus has been given to that most fascinating of subjects, the rearing of toy or tropical fish. This impetus has been acquired naturally, not by any extraordinary publicity on the part of the fish dealers or by any advertising campaign of stupendous proportions, but by the very fact that these tropical fish have a most interesting social life that unveils itself to the observer as he watches them. The fish are not difficult to raise, but unfortunately there is a sad lack of literature that will enable the newcomer in the field to be always one hundred percent successful. Many of the fish are highly and beautifully colored, some changing their colors while you look at them. This is particularly true of the males as they pose for the females while making love, and as one sits and watches them, one becomes imbued with thoughts of the possible psychological processes which might be involved. There are still many things to be discovered and which the amateur scientist himself can unearth. Very little has been done about applying to toy fish culture the Mendelian principle. Here again amateurs can help. Abnormal shapes and colors have not been developed to advantage in these subjects as they have in gold fish. So far there has been but a slight attempt at hybridization, but here the amateur scientists have stopped. Very few experiments have been made in the fields of environmental effects, or the changes which different kinds of food make.

Fifty tropical fish will live in an aquarium scarcely large enough to house two gold fish. They do not require the constant change of water which gold fish require, and it is possible that should you ever make up your mind to try the experiment, with even one pair of mature rainbow fish, or guppies as they are popularly called you will find that after several weeks your family has increased by 8 to 40 small fish. When they grow up, try to observe the males playing for the attention of the females, without being bitten by the fish culture bug.

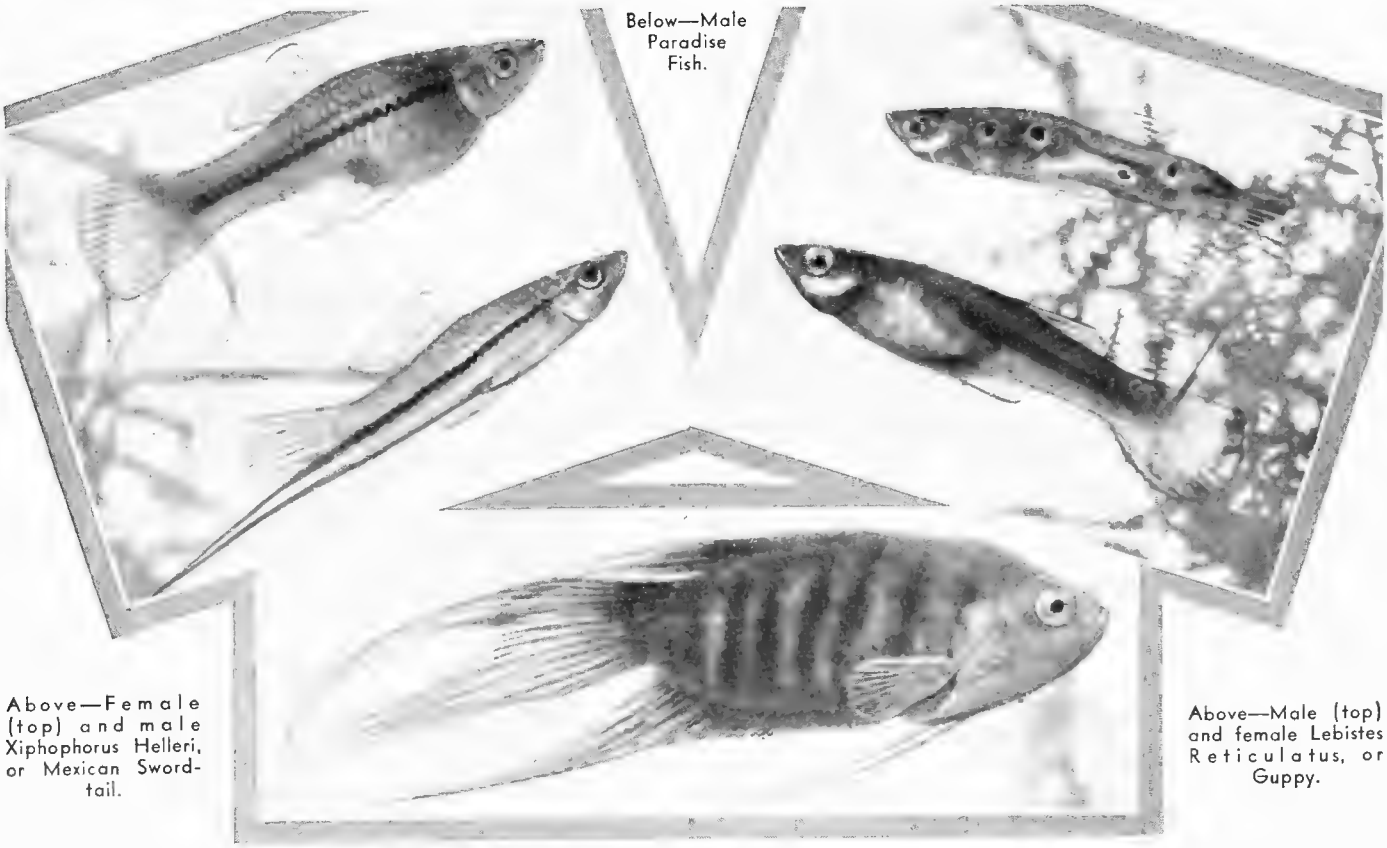
There are all kinds of toy aquarium fish on the market even for the thinnest of pocket books. The more showy and spectacular toy fish are more expensive and are often hard to obtain. These are usually exotic and come from tropical regions of the world. Practically all of them were first introduced by amateur aquarists who wanted to study new forms and learn under what conditions they breed. Many peculiar and at times weird facts were unearthed by them. It was they who studied our own American life-bearing fish, tiny creatures which, instead of laying eggs, bring living fish into the world; and it was they who brought the spotlight of interest upon the mouth breeder, a fish



Elodea densa waterweed and vallisneria spiralis, tape grass.

Cabomba aquatica, fanwort.

Myriophyllum acabratum, water miltoil.



Below—Male Paradise Fish.

Above—Female (top) and male Xiphophorus Helleri, or Mexican Sword-tail.

Above—Male (top) and female Lebistes Reticulatus, or Guppy.

which carries its eggs in its mouth, where the young are hatched and where the fry seeks refuge in times of danger.

But before all this could be satisfactorily accomplished adequate aquariums had to be devised, built and tried out. The so called goldfish-bowls did not work out as expected. Although they look ornamental they were useless to the fish fanciers. So they set to work and built tanks of various sizes and shapes. Square ones, rectangular ones and even cylindrical ones were tried and all worked successfully. Each particular tank was prepared with the idea of transplanting a bit of Nature herself into the home.

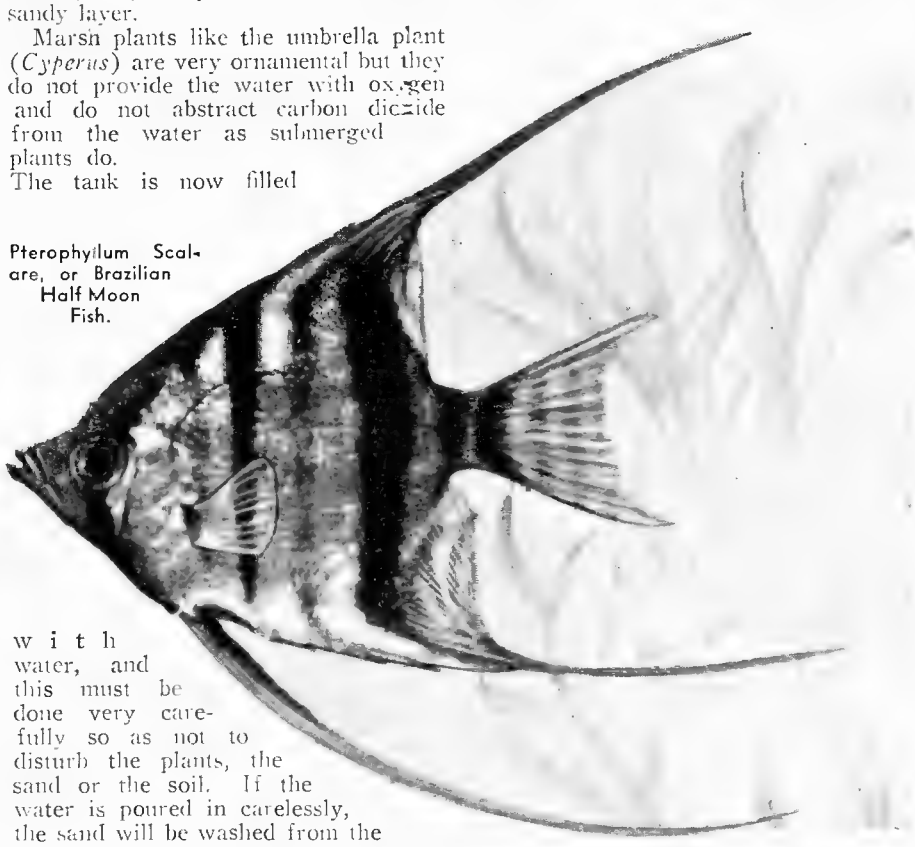
The aquariums of today are all based upon this fact, and they have become standard. First, in one corner of the tank a small piece of glass is puttied. This is a refuse corner where all dirt collects and where it may be easily removed by siphoning it off. Then a layer of good garden soil is placed upon the bottom of the tank in such a way that the shallowest part is at the refuse corner while the deepest part of the soil is diagonally opposite. Upon this garden soil, which is, of course, gently packed in place, a layer of freshly washed and absolutely clean sand is spread. This layer should be about an inch in thickness. The sand serves to hold the garden soil down and prevents it from muddying the water.

It is not particularly hard to wash the sand. Place a couple of handfuls in a pail. Fill the pail full of water, stir the sand vigorously and quickly discard the dirty water. Repeat this operation until the water is no longer discolored when the sand is agitated.

The greatest part has now been completed. It just remains to plant the aquarium with water plants, and when that is done, to fill it full of water. Tips, one and a half to two inches in length, are taken from *Cabomba, Elodea* or *Myriophyllum* and are imbedded in holes so that just the tips protrude out of the sand, for these plants are so organized that only that part which has grown in the tank will remain green. Plants which make few roots, such as *Vallisneria, Sagittaria natans, etc.*, are placed in holes of the sandy layer.

Marsh plants like the umbrella plant (*Cyperus*) are very ornamental but they do not provide the water with oxygen and do not abstract carbon dioxide from the water as submerged plants do.

The tank is now filled with water, and this must be done very carefully so as not to disturb the plants, the sand or the soil. If the water is poured in carelessly, the sand will be washed from the soil and the soil will muddy the water so that it will never clear itself. If, however, the filling is done carefully, the tank will always be clear. Fill a pail full of water and place it over a corner of the tank. Take a sheet of paper, (newspaper is perfectly good) fold it a number of times and place over sand and plants in the tank. Now, with the aid of a small rubber tube siphon the water (*Continued on page* 336)



Pterophyllum Scalare, or Brazilian Half Moon Fish.

Part of the Great Wall of China, along the top of which two carriages can be driven abreast.

Unveiling the Mysteries of the Far East

By Colonel P. T. Etherton

Formerly British Consul-General and Political Resident in Chinese Turkistan

FAR away in the heart of Asia along the northern borders of Tibet, a region which is very much of a sealed book to the rest of the world, are curious Buddhist sects who have from time immemorial given themselves up to a life of study and contemplation, and adding to the knowledge which their forefathers possessed. The world in general has benefited, and science and invention have figured largely among the secrets of China, and what lies behind the veil of her five thousand-year-old mysteries.

Although the first ship to reach the port of Canton, then the only one available, arrived there more than three hundred years ago, China is still very little known to the average person, who imagines it to be a land of almost constant strife, inhabited by an ignorant and uncivilized people who have contributed nothing to science.

The real China is far from that; it is the world's oldest empire, for China has been a nation since the first emperor came to the throne in 2753 B.C. Although it is true that there are probably well over two hundred millions of Chinese who are so poor that they have to keep their families on what can be purchased for six cents a day in American money, it does not alter their belief in cultured superiority,

A stretch of the Great Wall, a marvel of scientific construction, and the only man-made thing on earth that could be seen from the moon.

A Chinese taxi

and the type of civilization peculiar to themselves which the Chinese have evolved.

There has always been a spirit of exclusion in China, a firm conviction of superiority to the rest of the world; even their emperor was called the Son of Heaven, for he ruled over all beneath the sun, and those who came to the Chinese court, whether kings or envoys from another nation, were graciously conceded the privilege of crawling to the steps of the emperor's throne.

This condition was waived when King George III sent a mission to Peking, under Lord Macartney in 1780, for the British envoy had his own ideas on the subject of importance.

Nevertheless, in the elaborate reply sent by the Son of Heaven, King George was praised for his loyalty and devotion in sending the mission under the envoy, his poor slave and herald, the despatch concluding with the command, "Tremble and obey."

Although no census has ever been taken of China it is known that one-fourth of the world's population lives within its boundaries. Canton, the largest city, has a population of more than two millions, a third of whom live on the water, a city in itself, and one that is equally fantastic and impossible of understanding. These river folk are born on the boats or "sampans," live their days on the water, seldom going ashore except to dispose of their catch or to trade for food or other articles of which they stand in need. Here in this city on the water are floating shops, restaurants, dance halls and gambling hells; strident and discordant music comes floating over the muddy stream, a river polluted by garbage and grime, on which there rests continually a coating of foul, greasy looking deposit. No one, unless he be inured to unpleasant sights, should take to boating in the vicinity of this floating city. You are more than likely to come on the bodies of newly-born babies who have either died within a short time of their arrival on earth, or are surplus. The water serves as the last resting place, and there are no coroner's courts to ask the why and the wherefore.

Yet within the land city of Canton, where life is in its most primitive state and human nature at its lowest ebb, with streets so long and narrow that the sun penetrates but seldom, and then only for a few moments during the day, are dark and mysterious shops with pottery and cloisonné ware that Western science cannot surpass. In this artificial gloom thousands of Chinese live and have their being, producing things that are the wonder of the western world, toiling with a fatalistic outlook which is their heritage.

Of privacy there is almost none; you could shake hands with ease with a dweller in a house or shop opposite, for the overhanging eaves, set as closely together as the teeth in a comb, bend forward like gargoyles intent on malicious and dreadful gossip. The sky itself is almost hidden by these eaves and the high verandahs jutting out from many of the hovels.

Remarkable treasures are to be found in the pottery, the book, and the scroll shops; they are not easy to find in the gloom and darkness, although the shops are open to the world and few have windows or doors—merely huge shutters which can be readily removed and cause little trouble. They are gaudily painted and gilded fantastically, some lacquered, others daubed over with many colors as though a post-impressionist artist had been having a riotous day. Great plank shutters protect the contents of the more pretentious shops, and the presence of heavy bars and bolts indicates that thieves and prowlers are not unknown.

14,500 miles to New York. The Chinese claim to have invented the milestone. This one is 60 feet high, not counting the flagstaff.

Peking, the old-time capital and still regarded by the mass of the Chinese people as the hub of the universe, has a population of another million. Here are the palaces of the former emperors, and other wonderful buildings where the compass was first invented and gunpowder discovered, a contribution to science and invention that has effected so much destruction in the human race. These buildings show the immense wealth and resources of China in the days when the Son of Heaven was all-powerful, the most important man on earth.

During the forty centuries and more of the empire, the Chinese had no hereditary aristocracy properly speaking. The crown advisers were chosen from the wisest men in the land by examinations held under the presidency of the emperor. This system formed the leading feature of Chinese policy. No part of the imperial administration was so carefully organized, and the prize of a literary degree was at once a distinction and a passport to official appointment. There is nothing in the world that could rival the final tests for these degrees. The candidates comprised all those who had survived the eliminating process at the trials held in the provinces. The examination halls were famous throughout China, for within the narrow cells, each nine feet by five, into which the halls were divided, the flower of Chinese literary talent grap-

(*Continued on page* 338)

A doctor in southwest China. His prescriptions are made up from herbs, dried snakes, and tiger claws.

A Chinese theatre. Here are the orchestra, the players and the audience. The public highway is the favorite pitch.

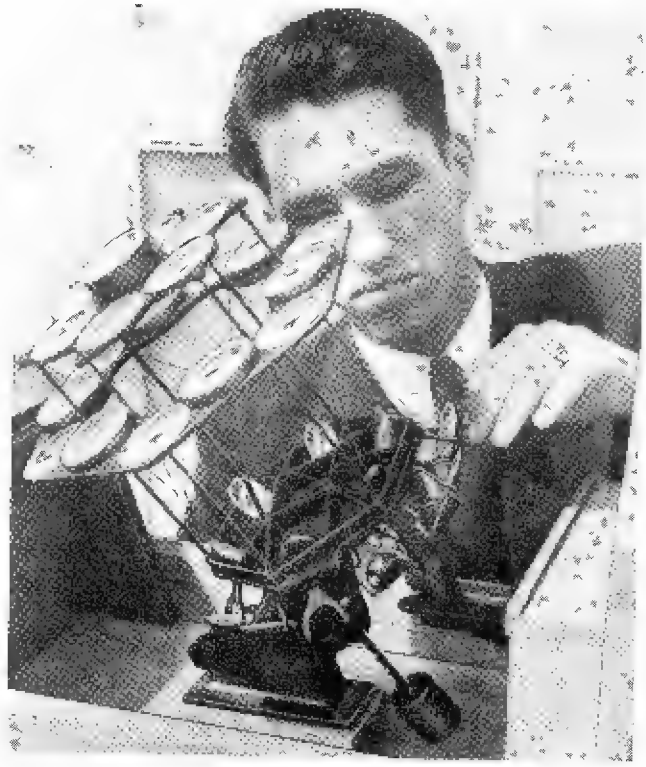
New Sun Motors to Produce Terrific Temperatures

The Sun Pours Forth Millions of Horsepower Every Minute of the Day. So Far, We Have Made Only Indirect Use of This Enormous Energy, in the Form of Coal, Oil and Water Power. Scientists Have for Long Been Making Attempts to Harness the Sun's Power Direct, But So Far Without Commercial Success. Some Suggested Methods for Utilizing the Sun's Heat Are Made Here

By Thomas Elway

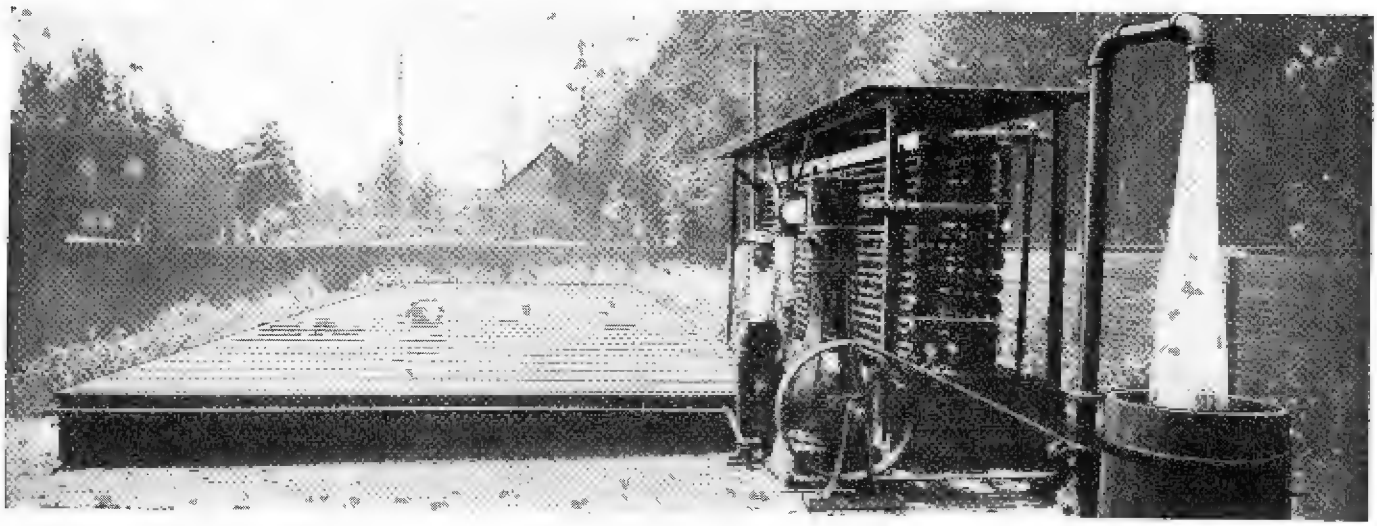
BRINGING the sun to Pasadena to make liquid diamonds, or to strip atoms of their coats of electrons so that scientists can learn more about the structure of matter, is the latest enterprise of scientists at the California Institute of Technology. Nor do the possibilities of this enterprise stop with the fusion of elements or the disruption of atoms made possible by the concentrated solar heat, for the devices to be used may give new life to the age-old problem of obtaining free power from sunlight.

The apparatus which the California physicists are now constructing is designed primarily to produce solar heat, rather than solar power. In many ways it is solar heat with which physicists are most concerned, for ample sources of power are available anyway in such forms as water power, coal or oil. Earthly laboratories are entirely lacking, on the other hand, in means for producing continuous degrees of heat even approximately as great as the heat of the sun's surface, or as great as the new apparatus for controlling solar rays may possibly provide.



A model of a solar furnace which may melt diamonds, built by scientists of the California Institute of Technology, Pasadena. Each of the 19 lenses sends its ray to a common focal point at the base of the instrument. Below—An experimental sun engine using sulphuric ether as the working fluid.

The hottest furnaces ordinarily used on earth run only to some 2000 or 3000 degrees, Fahrenheit. Temperatures about twice as great as this can be obtained, under favorable circumstances, in the centers of electric arcs. Many years ago Benjamin Franklin devised another method of obtaining very high temperatures, by passing large quantities of electricity suddenly through thin metallic wires or strips of metal foil. When this happens the wire or foil explodes violently, producing for a tiny fraction of a second temperatures recently computed by Dr. J. A. Anderson of Mount Wilson Observatory, to reach perhaps 30,000 or 40,000 degrees. It is by means of this method that Dr. Anderson and his colleagues have obtained much of the present-day information about the structure of atoms, but unfortunately these electric temperatures last for only a thousandth of a second or less, so that substances cannot be exposed to them for any length of time.



Left—Side view of one of the sun-power boilers, heated by sun's rays reflected by the parabolic mirrors, which is used to generate power for irrigation pumps in Egypt. The inclination of the mirrors is slowly altered through gearing so that at all times of the day they face the sun. Right—View of the engine shed, from the irrigation pump end.

The surface of the sun, on the other hand, has an enormously greater temperature and maintains that temperature continually, thanks to vast amounts of radiant energy generated inside the sun which flow outward continually through its mass. The most recent measurement of the temperature of the sun's surface, communicated last winter to the American Astronomical Society by Miss Charlotte E. Moore, also of Mount Wilson Observatory, places this temperature at 9,869 degrees Centigrade, equivalent to nearly 18,000 degrees Fahrenheit. This is somewhat greater than the usual estimates, but is probably correct. In any event, the surface of the sun unquestionably is far hotter than anything which scientists can duplicate on earth. Things happen to atoms of matter in the sun which do not happen on earth. That is why physicists would like so much to get earthly furnaces approaching the same temperature.

One of the commonest elements, carbon, has never been fused in terrestrial laboratories. A little carbon is vaporized in electric arcs, but droplets of liquid carbon have never been examined because they cannot be produced. No one knows what they would resemble. Perhaps the liquid would be dull and black like solid carbon, or like the graphite of lead pencils. Perhaps, on the other hand, it would be as brilliant and scintillant as a diamond. It is not impossible that *liquid* carbon, could it be produced, might cool into actual diamonds instead of into black carbon grains.

No scientist is much interested in making artificial diamonds to be worn as jewelry, but that is by no means the most important use for these gems. Diamond is the hardest substance known. It has remarkable mechanical, optical and atomic properties. Were it possible to cast fused diamond in laboratories into shapes of scientific or practical utility, enormous advances might be possible in the study of crystals, the handling of the harder metals, and in many other directions. Probably the making of fused carbon, whether or not this becomes fused diamond, will require great pressures as well as great heat. Present resources of earthly laboratories can provide the pressures, but they cannot provide the heat.

One difficulty which prevents the attainment of very great temperatures in ordinary furnaces is that the heat usually is supplied from the outside of the pot or crucible containing the substance that one wants to melt. No known material that might be used for crucibles could resist the enormous heat necessary to fuse carbon. The crucible would melt before the carbon did. A part of this difficulty can be avoided by using the

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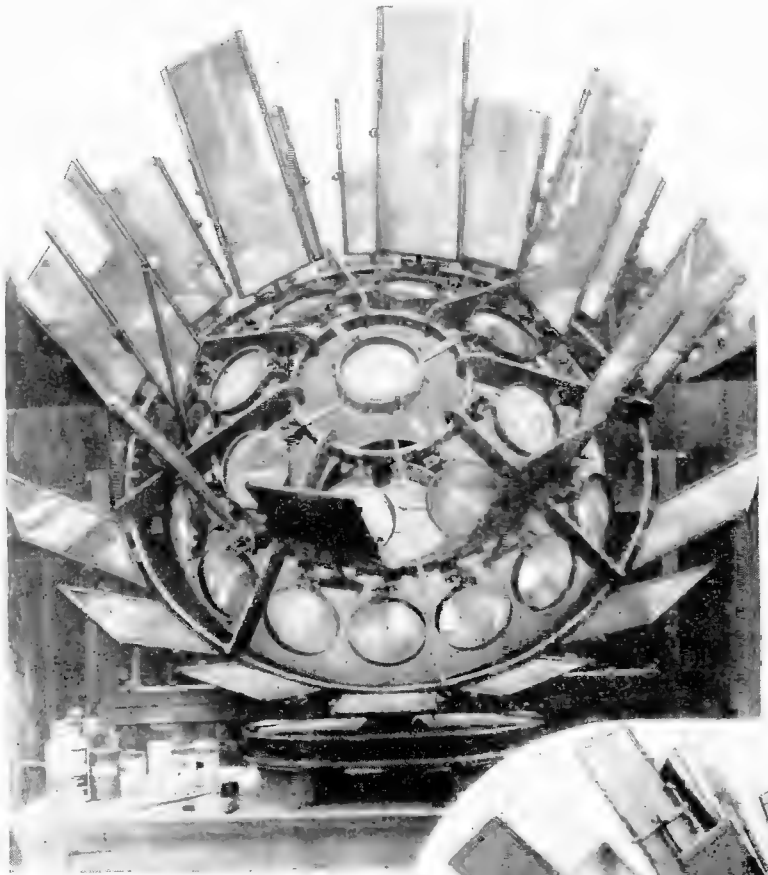
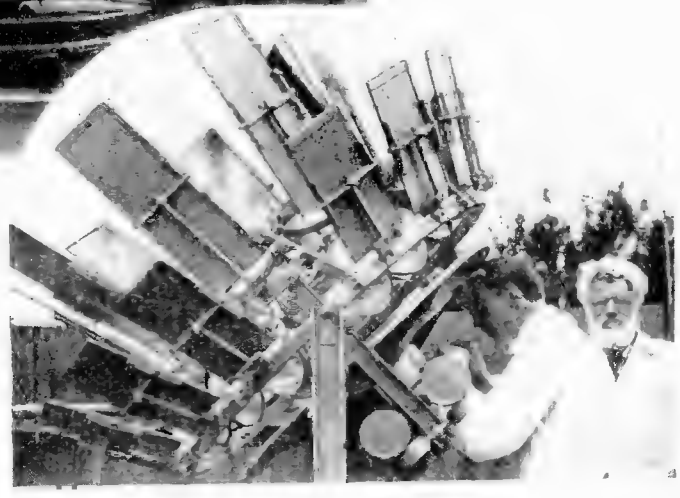
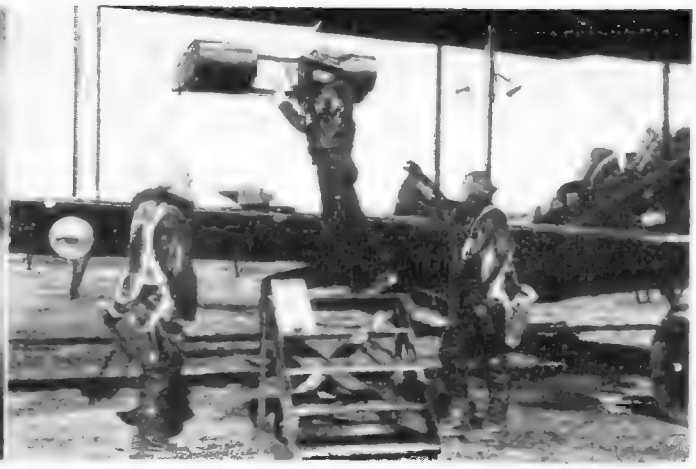




The above machine, invented by Marcel Moreau, Jr., of San Francisco, catches the rays of the sun, deflects them to a focus by lenses, and creates a heat at that point sufficient to melt refractory substances. Right—The inventor and his father.

Above the clouds on an insect hunt. Only the light, small bodied, wind-borne insects are found in this region.



A streamlined strap is mounted on each wing of the airplane to equalize head resistance.

Planes Trap Migrating Insects At High Altitudes

The Mysterious, Sudden Appearance of Hordes of Devastating Insects in Localities to Which They Are Foreign May Be Explained by Investigations Based on the Study of Insects Trapped in the Clouds by Airplane

By G. H. Dacy

SIMULATING the seasonal flights of the birds which follow the sun, the kings and queens of the insect world, as disclosed by fascinating research of the upper atmosphere also participate in migrations. Entomologists have been using the airplane to collect specimens at altitudes never previously invaded for such purposes.

New data for the bibliographers of the strangest facts known to science have been furnished. For example, balloon spiders, which have no wings and are devoid of flight power, have been found by the airplane hunters at altitudes of 10,000 feet above the ground. Curious to relate, the insects found at the maximum elevations—some as high as 2½ miles above the earth's crust—are the snails or sluggards of flight. They are in the light-weight small-bodied bugs, weaklings of the insect world, whose normal habitat is the earth, or very close to it. Almost incredibly small mites, gnats, wasps, flies and similar midgets among the bug ranks were caught at amazing distances above the surface.

Effective insect traps were evolved and streamlined for attachment on the wings of three national airplanes. One trap was mounted on each of two wings so that they could be operated simultaneously in order to equalize head resistance. Each trap has 3 compartments, the two end units being insect-proof while the central compartment is open and exposed directly to the air blast as the plane races through cloudland. The insect-proof compartments, respectively, accommodate 8 screens which by means of control wires manipulated from the cockpit of the plane can be moved from the enclosure and exposed to the full sweep of the wind as desired for 10-minute intervals.

Each screen is coated with a thin layer of sticky material so that any insects in the atmosphere at the point of exposure will adhere to the snare when they come in contact with its surface. The mesh of the wire is coarse enough so that it allows the air blast to sweep through it while the wires are close enough together to (*Continued on page* 349)

Inflating a pilot balloon preparatory ta making upper air investigations. These balloons are used to ascertain wind direction and velocity at the different altitudes.

Inspecting air mail near the Mexican border for contraband. Recently several pink boll worms, destructive cotton crop despoilers, were found in a sample of cotton sent by air. These uninvited visitors are not wanted.

Can Science Measure Luck?

Do You Play Hunches? Have You Ever Held a Perfect Bridge Hand? How Many Straight Flushes Have You Filled? Is Success a Matter of Chance or Skill? What Is the Technique Employed by a Good Gambler?

By H. H. Sheldon

Professor of Physics, New York University

THE Grand National Steeplechase was run at Aintree near Liverpool, Eng., on March 27th, and Emilio Scala, coffee shop proprietor, collected about $1,900,000 on his $2.50 lottery ticket. In the same way Clayton C. Woods, of Buffalo, New York, collected nearly $900.000 and George Dyamond of Africa nearly $600.000. That sounds a lot like luck, and maybe luck is the proper name for it, but anyone can do the same thing if he is willing to try it often enough and live to an unprecedented age. How? Let us analyse this lottery.

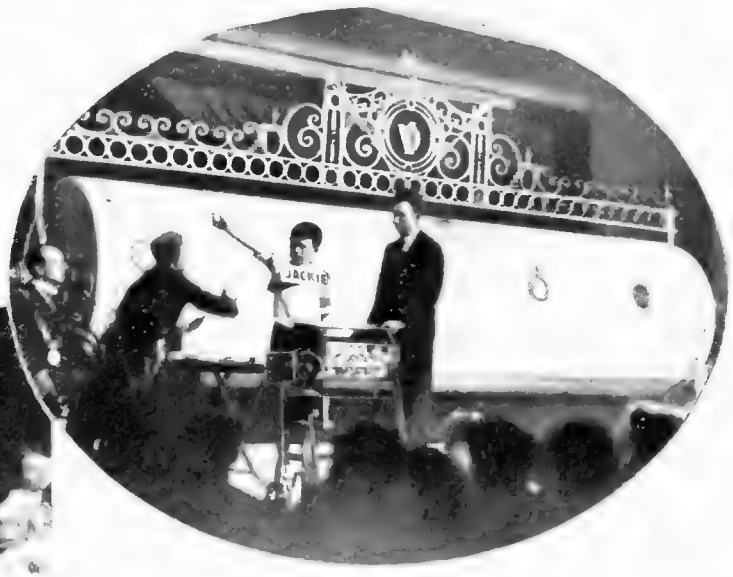
Just how good are your chances of getting four of a kind?

According to reports between $3.000.000 and $9.000.000 was paid into this lottery for tickets. Let us take the $8.000,000 figure to simplify our arithmetic. One-quarter, or $2,000.000 of this money, went to the Irish hospital for whose benefit the lottery was held. Assume that $2.000.000 more went to cover the expenses incidental to the lottery. It was less than this but of about this order. This leaves $4,000.000 to be distributed to holders of tickets. Half the money has disappeared. Your share is worth only $1.25. That is all you would get if it were distributed evenly among the ticket holders at this point.

But what is your chance of winning the first prize? If $8.000,000 were paid in then, at the $2.50 rate, there were 3,200,000 tickets sold. Out of the 3,200,000 tickets you have one chance that yours will draw the winning horse. Your chance is one in 3.200.000. If you were to live for 3.200,000 years and each year were to buy a ticket on this same event then you would probably win first place in this steeplechase once. You could look forward to this with reasonable certainty. You might win on the first trial, you might win on the three millionth. That is what makes it interesting. But if you kept on for the full 3,200.000 years you would ultimately lose money. You would ultimately pay one-quarter of your money to the hospital and in addition the cost of running one lottery would fall to you.

The great interest in the Grand National together with the legalization of gambling in various places, Nevada for example, shows a renewal of interest in gambling. This is not surprising, for man is addicted to enjoying those things which most nearly resemble life itself. The gambling instinct is most apt to show itself when a depression occurs. When the ordinary means of earning a livelihood fail, man is likely to try his luck at the gaming table; for every one believes he is naturally lucky; those who do not are rare.

Perhaps you take exception to my statement that life itself is a gamble? Let us see what Henri Poincaré, the great French mathematician, has to say on this point. "The greatest bit of chance is the birth of a great man. It is only by chance that there occurs that meeting of two germinal cells of different sex containing precisely, each on its side, the mysterious elements whose mutual reactions must produce the genius. One will agree that these elements must be rare, and that their meeting is still rarer. . . . How slight a thing it would have required to deflect from its route the carrying spermatozoan. It would have sufficed to deflect it a minute fraction of an inch, and Napoleon would not have been conceived, and the destinies of a continent would have been changed." But this does not apply only to the genius. Whether you count yourself a genius or not, the chance that a person exactly like you in every detail should have been born during the entire history of the world,



Below—Mixing the four million counterfoils in preparation for the drawing for the Hospital Sweepstakes in Dublin, Ireland.

Above — The counterfoils are placed in the huge cylinder. The boy is drawing the names of entrants in the race.

Come seven! How often should that fervent prayer be favorably answered?

is so slight as to be negligible. Yet here you are!

Can science measure luck? The answer to this is yes—perhaps not always, but usually. Let us take a simple example. Let us apply our method, the law of probability, to dice. A single die has six sides numbered from one to six. When rolled it may stop with any one of these sides up. Supposing I wish to bet that the five will turn up. Then I should get odds of five to one; for there are five ways which it can turn up to show numbers other than five and only one way it can turn to show a five. If I play long enough at these odds I will eventually come out even. If I get better odds I shall make money if I keep at it. If I accept lesser odds I am sure to lose in the long run, even though I may sometimes have a series of wins.

If I have a pair of dice then for each side of one the other may turn up in six different ways. That makes thirty-six ways in all. What chance have I of throwing a seven? I may throw 6-1, 1-6, 5-2, 2-5, 4-3, 3-4. That is six different ways of getting seven out of a possibility of thirty-six ways. Again the odds are five to one against me.

In a game of poker what chance have I of drawing four aces? In 52 cards there are four aces. My chance of getting the first one is four in fifty-two. In the remaining fifty-one cards there are three aces. My chance of a second is three in fifty-one. Similarly the chance of a third is two in fifty and of a fourth one in forty-nine. The chance of getting all four is the product of these separate chances. It is but one in 270,725!

Can you make money by gambling at Reno? Not likely. If you stay long enough you will come out *minus* the commission that you pay to the owner of the gambling house, or, if you are betting against the house, you may be sure that your chance of winning is less, by a very definite percentage, than the chance you are paying for. You will never get an even break. The owner will set his odds to collect all he thinks he can get away with and yet not discourage his customers. If you must gamble your only chance to win is to bet on something which requires some kind of judgment which you possess. It may be that you are a keen judge of horses, of boats, of boxers, of baseball teams. Whatever it is you must become expert in it if you are to come out ahead. But then would you call it gambling?

The science of gambling, more respectably known as the laws of probability, underlies our whole knowledge of science today. Consider radio-activity, for example. We are told that one radio-active element is disintegrating at such a rate that it will have dwindled to half its present amount in five billion years. How do we know? Radio-activity has only been known since the latter part of the last century. No one has observed it for even half a century, much less billions of years. Yet from the laws of probability we know not only this but more than this. We know that there are so many atoms in a speck of radium that in spite of the fact that there is a continuous release of radio-active products it is a very rare thing, from the point of view of an atom, to have one of these radio-active explosions. To quote Prof. W. F. G. Swann, President of the American Physical Society, speaking of a similar phenomenon, "If a molecule were to go about saying that it had once seen one of its brothers which had lost an electron, it would be less likely to be believed than would the story of a miracle which had claimed to be seen by only one person since the dawn of history. Yet these

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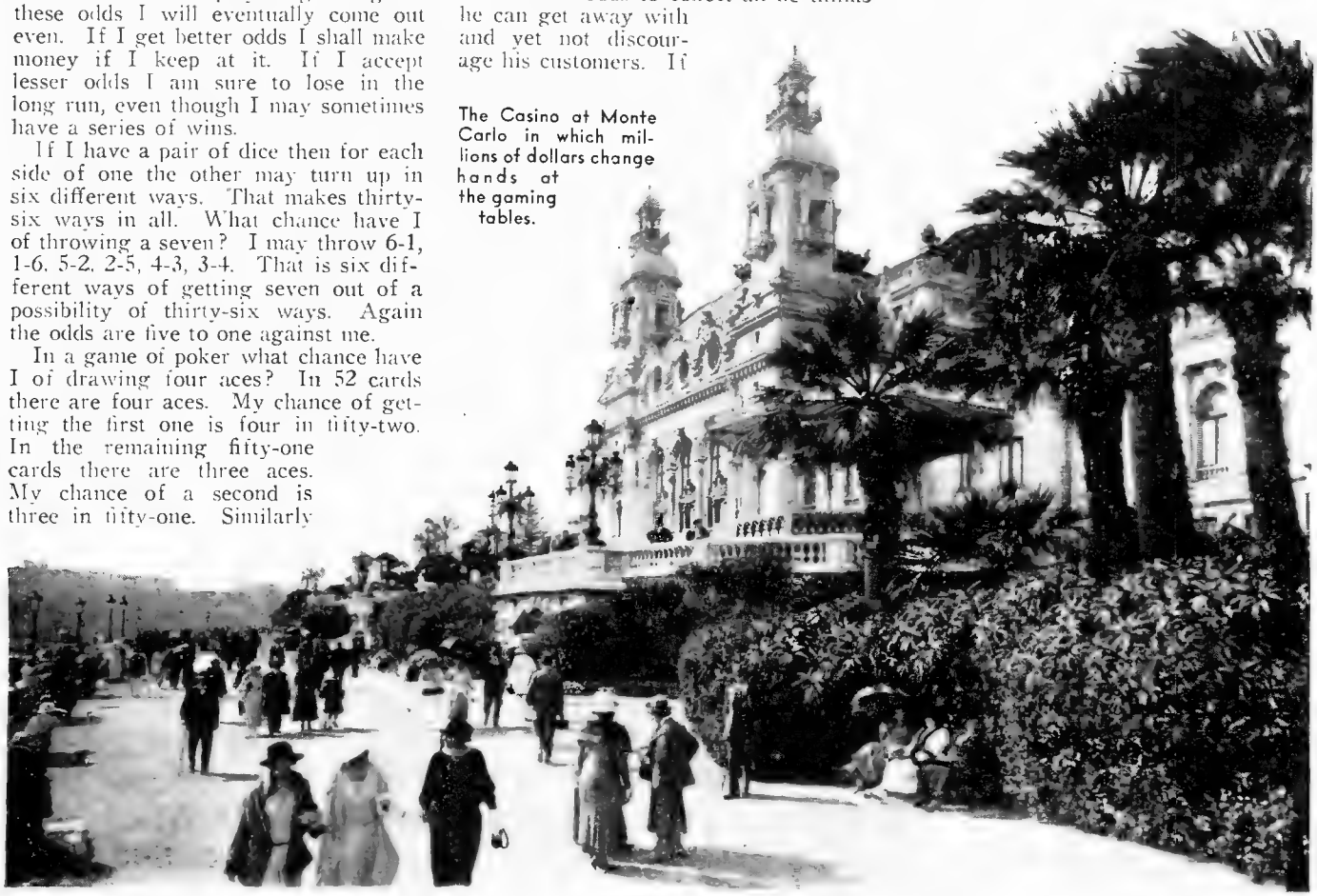
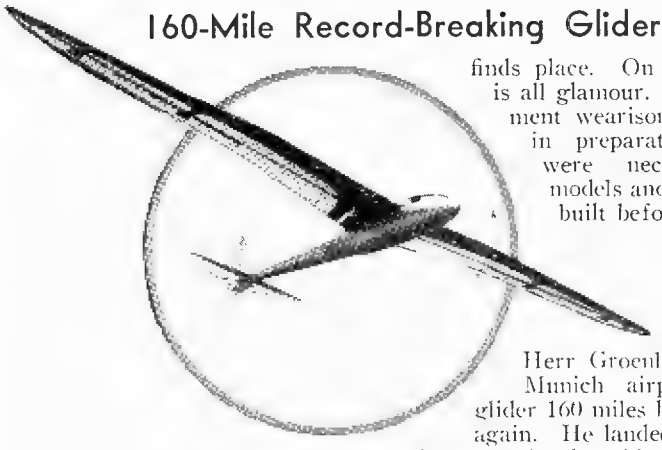


The Casino at Monte Carlo in which millions of dollars change hands at the gaming tables.

IN THE SPOTLIGHT OF SCIENCE

160-Mile Record-Breaking Glider Flight



THE Germans, prohibited by the terms of the Versailles treaty from developing powerful motor driven airplanes, turned their attention to craft capable of engineless flight and have reigned supreme in this line of endeavor ever since. The history of gliding in Germany is an epic tale in which one record breaking adventure after another finds place. On the surface the story is all glamour. But for each achievement wearisome months were spent in preparation, numerous trials were necessary and several models and complete gliders were built before the perfect (at that time) craft was evolved and the flight made.

The latest dispatches relate that Herr Groenhoff took off from the Munich airport, and piloted his glider 160 miles before he touched earth again. He landed at Kadan, across the Czecho-Slovakian frontier, thus establishing a new world's record. Our photo shows Herr Groenhoff's glider above Munich immediately after the start of what proved to be a most auspicious flight.

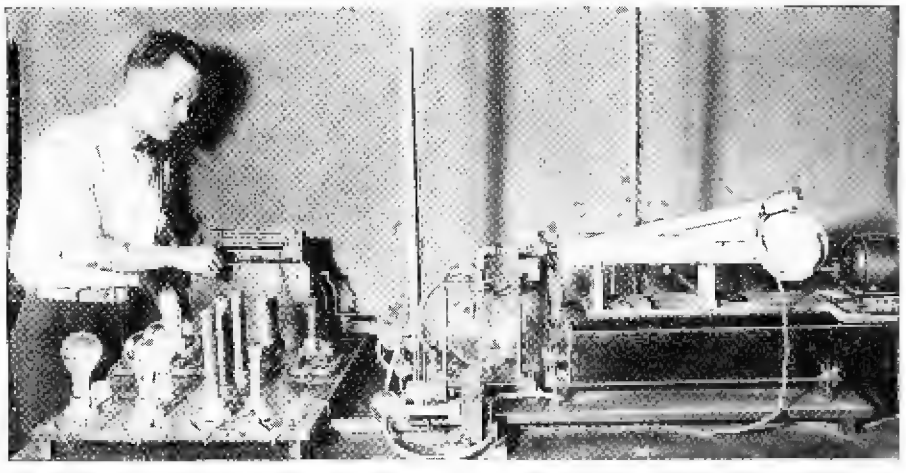
Note gull-like form of the glider. It is a far cry from the crude constructions of Lilienthal, Pilcher, Chanute and Herring.

Soap Dust—Dynamite in Disguise

FOLLOWING a number of unusually disastrous industrial explosions the U. S. Department of Agriculture conducted a series of experiments which proved that the dusts incidental to the manufacture of many products constitute a serious fire hazard. Among the offending minute particles which were labeled as dangerous when present in sufficient quantities are sulphur, sugar, spice, coal, grain, starch, leather, and cotton.

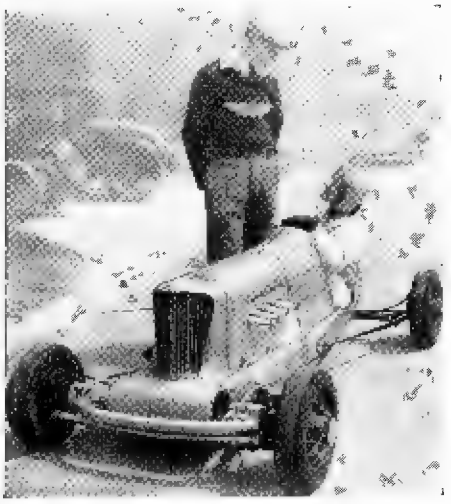
Now the U. S. Bureau of Mines announces the results of the separate and independent researches which they have been making along the same lines. According to their tests soap dust is more highly explosive and dangerous than coal dust.

These investigations tend to prove that soap dust must be most carefully handled. In every experimental demonstration, the explosions produced by soap dust were more violent than those produced by coal dust. The Clement-Fraser apparatus pictured here was used in making the tests from which these strange conclusions were drawn.



Flexible Mirrors

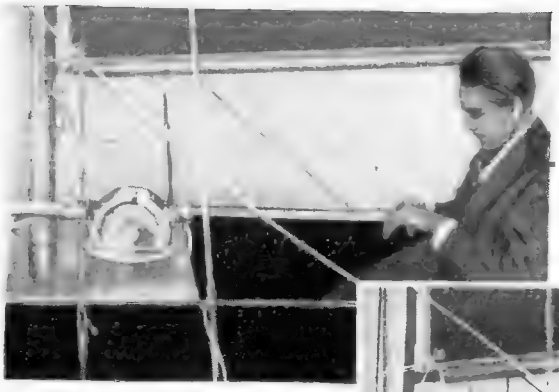
TWO young physicists at the California Institute of Technology have discovered a means of producing a mirror surface upon cloth, isinglass, mica, cellophane and other flexible materials, that can be extremely useful for many purposes. Dr. John Strong and Dr. C. H. Cartwright, the discoverers of the process, built a small electric furnace capable of generating a temperature of 2000 degrees centigrade. At this high temperature, within a huge high-vacuum tube, metallic silver is evaporated and deposited over the articles where a silvered surface is desirable. The silver vapor condenses evenly on the articles, forming a beautiful lustrous coat of metal. It is possible to use metals other than silver in this process.

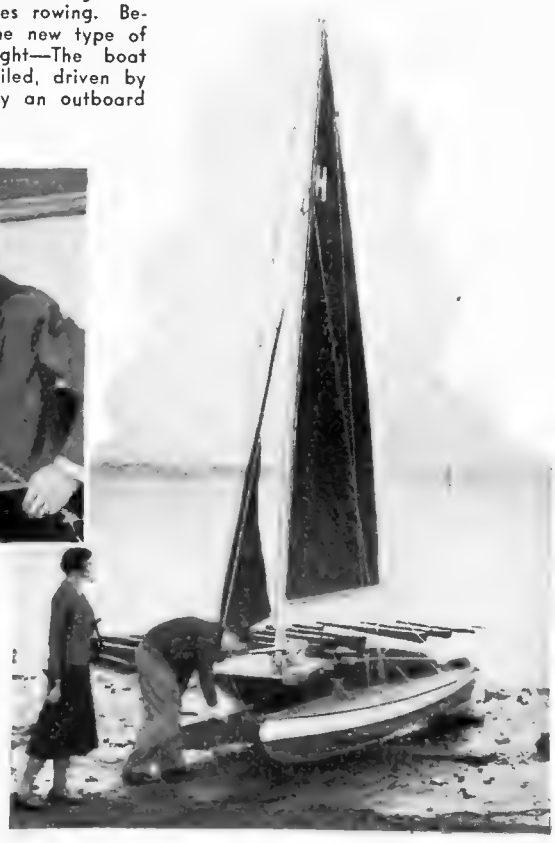


70 Miles an Hour in 500-Pound Auto

THIS tiny Dorntraeger front-drive automobile might look as though it were only a model for a real life-size car, but it can make 70 miles per hour, run 50 miles on a gallon of gasoline and you can garage it under the back steps or in a small barn if you have one. It took Edward A. Dorntraeger two years to build this midget "limousine de luxe" as he is explaining to Viola Rosebrock, and the job was done entirely by hand. Chased aluminum was used for the body. Over all dimensions are: height 26 inches, length 86 inches. It has a 66-inch wheel base and weighs only 500 pounds. Prototypes of this tiny gasoline bug might become very popular as our love for speed and safety increases.

Three-Type Auxiliary Sportboat Makes Début





Left—Lee Hampton, the inventor of this sport boat, demonstrating the mechanism which replaces rowing. Below—Another view of the new type of manual propulsion. Right—The boat which may either be sailed, driven by manual propulsion, or by an outboard motor.

THIS boat, which can be sailed, driven by manual propulsion, or powered with an outboard motor, has been successfully tested by its inventor, Lee Hampton, who has called it the Hampton Sportboat.

In addition to the regular equipment for an outboard-motor-driven boat, Mr. Hampton has provided another type of propulsion. Forward of the cockpit he has installed a hand-propelling mechanism. Back of the forward deck is the operator's seat, similar to that found in a racing shell, for it slides backward and forward.

In front of the operator is a driving bar with a crosswise handle. This is pulled back, as an oarsman would pull his oar; the mechanism spins the propeller driving the boat forward. At the end of each stroke the driving rod returns forward freely and a flywheel maintains an approximately constant propeller speed. After a few strokes, the initial inertia is overcome and manual operation requires less exertion. The craft is reported to move forward at quite a satisfactory rate.

The steering apparatus resembles that of a plane, somewhat. You steer with your feet, shifting the rudder and the propeller at the same time. The propeller is protected by a skeg that automatically lifts it clear of obstacles, when shallows, driftwood, or rocks are encountered.

When the outboard motor is used, a control cable provides the means of raising the skeg and propeller out of the water and fastening them.

If the boat is maneuvered as a sailing craft, the 16-foot pontoons and the 5½-foot beam provide sufficient stability to allow the safe use of the 22-foot mast and 100 square feet of triangular mainsail and jib, which can be raised to convert it very quickly into a sailboat. No centerboard is necessary.—*Boc Shurmacker.*

Windmill Motorless Plane

QUITE similar to the glider is this windmill motorless plane, which is being experimented with at the Tempelhofer Airfield at Berlin. Hans Richter is the pilot we see in the plane, which has, as yet, remained on the ground.

It is unique among gliders in that above the 30-foot wings of the plane a four bladed propeller is attached, which rotates as the plane moves. This device is supposed to furnish stability. For the ground tests, it is being utilized to determine the resistance of the air. The weight of the plane is about 150 pounds.

Mammoth Electric Lamp

THIS colossal electric bulb, a British product, was exhibited at the British Industries Fair at Birmingham, England. It is reputed to be the largest ever manufactured for commercial purposes. In America, we have our 50,000 watt lamp made by the General Electric Company, which compares rather favorably. Although this lamp produces a brilliant light, the intensity is weak in comparison with the flashlight bulbs now obtainable.

Piccard and Kipfer Ascend 52,000 Feet in Balloon

ON May 27, 1931, Professor Auguste Piccard and his physicist, Charles Kipfer, succeeded in a third attempt to explore the stratosphere, 52,000 feet above sea level, a height which no man has ever before reached. The main purposes of the flight were not to attain an altitude record, but to obtain information on the radioactivity of the stars and the variation of the strength of this radioactivity at various heights; to obtain new data on the origin of cosmic rays, and to make measurements of the ionization of the air.

For the flight, the two scientists were enclosed in an airtight aluminum sphere seven feet in diameter, attached to a hydrogen balloon, 100 feet in diameter, with a gas capacity of 500,000 cubic feet. A supply of oxygen was constantly being fed them from oxygen tanks, while the balloon was in flight.

Their first attempt to reach the stratosphere, September 14, 1930, which was fully described in our December, 1930 issue of this magazine, failed because of an insufficient supply of gas. The balloon did not rise. The second attempt was defeated by high winds.

Autos Ride on Roads of Cotton

WE don't wish to set ourselves up as prophets, but the latest developments in road construction methods cause us to venture that in the very near future, should the technique now under test be adopted, highway surfaces will be unrolled from huge spools and laid upon the roadbed much as one places a rug upon the floor. This experiment was made near Gonzales, Texas. In the new process a fabric covering is laid upon a coat of tar, which has been previously superimposed upon a granite base.

A highway has been given a fabric cover as a finishing surface in a recent experiment. Results were highly satisfactory. This photo shows a workman unrolling the ribbons of cotton fabric upon which the autos will travel.

The new Boeing mystery bomber, snapped at Boeing Field, Seattle, Washington, just before it was taken aloft for its first trial flight.

Boeing Mystery Bomber an "Angel of Death"

UNCLE SAM'S newest flying fortress, a giant bombing plane, built at Seattle, Washington, received its first tests on Boeing Field at Seattle recently. Construction of this mammoth heavier-than-air machine has been under way for nearly a year. The characteristics of the ship have been shrouded in mystery; details have been carefully withheld both by the factory officials as well as by the government inspectors. However, it has been ascertained that the new "Death Angel" has a wing spread of eighty-six feet and is powered with two 575-horsepower motors. The power plants, which are mounted on the wings, are expected to drive the plane at a speed much greater than that attained by any other bomber. A full-load ceiling of 16,000 feet is claimed for the craft. Besides her regular crew of five men and armament of four machine guns, mounted fore and aft, this "flying battleship" is capable of carrying more than a ton of explosives.

The photo was snapped as the new Boeing bomber was wheeled out for its first test flight over Seattle.

Eggs 10 Months Old—Still Fresh

THE problem of preserving eggs over extended periods of time is solved, according to Mr. T. L. Swenson, bacteriologist in the Food Research Division of the U. S. Department of Agriculture. Mr. Swenson claims that the impairment in quality in cold storage eggs results from a loss of moisture and carbon dioxide. Prevent the escape of these two gases and the eggs so treated will retain their original flavor as long as ten months.

The eggs are first dipped in oil in an airtight chamber. While still in the oil bath the pressure in the container is reduced to form what is termed a "partial vacuum." The pressure within the egg shells falls to a correspondingly low point. Carbon dioxide gas is next introduced into the container until the pressure rises to normal atmospheric pressure (nearly 15 pounds per square inch). Now the pressure outside the shells being greater than that within, the carbon dioxide and the residual air push the oil into the pores of the shell, forming a perfect hermetic seal.

T. L. Swenson, bacteriologist in in the Food Research Division of the U. S. Department of Agriculture, photographed with the apparatus he designed to preserve eggs.

The ditch digger that cuts a trench through earth as easily as a man goes through a pile of dust with a broom.

Pipe Laying in the Modern Mode

PIPE LAYING doesn't present much trouble to the Dutch in the Zuyder Zee section if this photo is admitted as evidence. They use the machine you see pictured at the left. The ditch digger literally sweeps the earth away and leaves a shallow, semi-cylindrical trench which is exactly what is required.

Get ready, get set, go . . . These child cyclists are about to start the first baby motorcycle speed race held in the famous Rutt Arena of Berlin.

Baby Speed Demons Enter Motorcycle Race

THEY start training them young in Germany . . . witness this trio of grim motorcycle racers, so sure of their prowess that each has taken a particular friend along for the ride! Though the ages of the entrants in the first Lilliputian race of its kind in the Rutt Arena of Berlin range from two to eight years, these little contestants appear to be taking the race very seriously indeed.

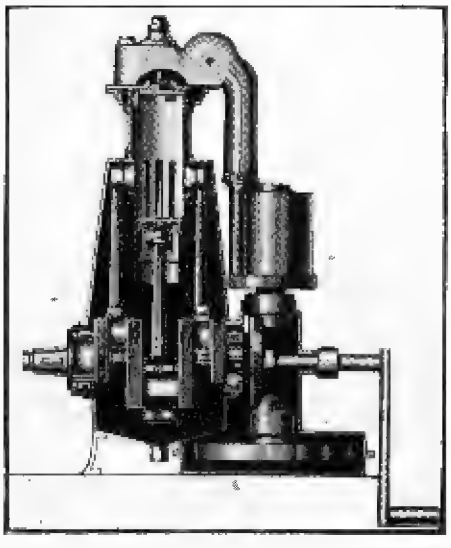
The youngsters' motorcycles are actually power driven, each one being equipped with a ½-horsepower motor.

Silent, Light Weight, Ignitionless Aircraft Auto Engine

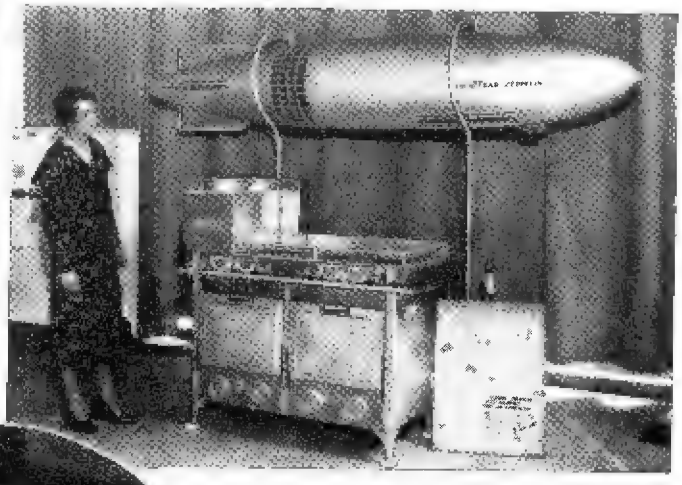
BOTH French and German government experts are reported to have been favorably impressed by the new Romeiser engine, designed for use in both airplanes and cars. For the benefit of our readers, we are presenting the sectional diagram of its operation below. If adopted, it is expected to work a marked change in air and automobile transport.

The engine uses heavy petroleum oil as fuel and requires no carburetor, no magneto and no sparking plugs, it is claimed. As no ignition system is required and as the fuel is very difficult to ignite, the most dangerous fire hazard will be eliminated from autos and planes powered with the Romeiser motor. In addition it has fewer parts than the average motor, 78 as compared to the several hundred in each of the other makes of engines.

The motor, because of its simplicity, is 40 per cent cheaper to construct and is reputed to consume half as much fuel as other types that perform the same work. It has an efficiency rating of between 50 and 60 per cent. The best of the petroleum engines are only 25 per cent efficient and the Diesel (which it resembles somewhat, using the same kind of fuel) is 36 per cent efficient. The engine is said to work silently.



Though this stove weighs only 110 pounds, it has all the equipment of a hotel cooking unit.



Right—This aluminum stove has place for eight pots, but only four burners are needed to heat them. Below—Miss Ruth Peters firing the liquid gas rifle exhibited at the Chicago Outdoor Show, in the Coliseum. The gun holds 40,000 rounds of ammunition and is ideal for rifle ranges.

Aluminum Stove for the Dirigible "Akron"

THIS stove looks but a little larger than a kitchen range to us . . . it weighs only 110 pounds. Yet on it will be prepared the food for the entire crew of the giant naval airship, *Akron*, now under construction at Akron, Ohio.

It is built almost entirely of aluminum and every attempt has been made to minimize its weight. The stove has places for eight pots, but only four burners are needed to heat them. Enclosed pans under each burner conduct heat to the rear of the stove, so that the top is evenly heated. The stove burns compressed natural gas. An aluminum gauze surrounding and enclosing each flame prevents its spreading beyond safe limits and igniting any stray gas. Pilot lights that burn at all times lessen the danger of fire or explosion. The stove has two ovens.

Liquid Gas Rifle Latest in Arms for Shooting Galleries

THE rifle Miss Ruth Peters is firing was demonstrated to visitors at the Chicago Outdoor Show. Its distinction lies in the fact that it is a liquid gas rifle and does not require the use of powder or cartridges. The weapon is the product of the Liquid Gas Rifle Range, Inc., Rochester, N. Y. The gun can fire 40,000 rounds with one loading. Ammunition is supplied by a tank of liquid carbonic acid gas, held at a pressure of 50 pounds per square inch, which is connected to the gun. The rifle is noiseless, smokeless, and has no recoil.

This gas rifle seems to be an ideal weapon, but we are very much afraid that there are certain features that limit its widespread adoption. Perhaps if the gas container could be made sufficiently small and conveniently portable, a really satisfactory and practical weapon for outdoor sports would result. Some inventors should get busy.

Portending Droughts

AMERICAN glaciers, as rain and snow gauges, disclose some very disquieting possibilities about the future water supplies of the western states, both for drinking water and for hydroelectric power, according to Dr. F. E. Matthes of the United States Geological Survey, who suggests that accurate measurements be made periodically.

Studies have shown that one of the glaciers on Mt. Rainier seems to have shortened nearly three-quarters of a mile since 1857. This decrease is a serious matter to Tacoma, which gets a part of its power supply from the river, which finds its source in the glacier.

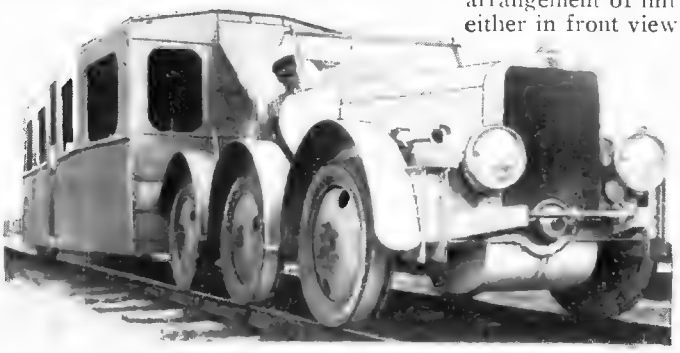
Press a Button and Photograph Yourself

A NEW development in photographic portraiture, which permits the subject to pose and take his or her own picture in quiet and contemplative solitude, with due regard for pet vanities and without the admonitions of a photographic assistant, was demonstrated in New York City to invited guests at John Wanamaker's by Luther J. Simjian, director of the photographic laboratory of the School of Medicine at Yale University.

Although the studio and apparatus embody new ideas in photography, Mr. Simjian says that the most important advance is in the psychology of photographic portrait making. The interest the subject displays in posing himself for front view or profiles induces the naturalness of expression that makes fine likenesses. In other words, no more watching for the little bird. Mr. Simjian has spent years in developing his method and building several experimental machines, but there is nothing tricky or complicated about the new method.

The subject enters the studio alone and remains alone. This reduction from life size to actual portrait size is effected by a concave lens in front of the mirror. When the desired pose is ready the sitter presses a button and the view is recorded by a hidden camera of conventional type. After all, a photographer never knows when you look most natural. Who, then, is a better judge than yourself to tell you if a photograph really does you justice. Photographing yourself is the best psychological method. By an ingenious arrangement of mirrors, he sees himself either in front view or profile, his image appearing in a mirror in the exact size in which his finished portrait will appear.

During the various phases of developing the system, Mr. Simjian tested his machines on Yale students.



This is the gasoline-driven engine, equipped with rubber-tired wheels, which makes the run between Issoudun and St. Florent.

Rubber-Tired Railroad Cars

THE steel wheels of our railroad cars are responsible for a good deal of the noise, bumping, and shock connected with this form of travel. To eliminate such inconveniences and add to the comfort of the passengers, France is experimenting with rubber-tired car wheels. Rubber-tired wheels have already been put on a gasoline-driven car used on the line running from Issoudun to St. Florent.

Power Ship "Jacona" Is Huge Floating Generating Station

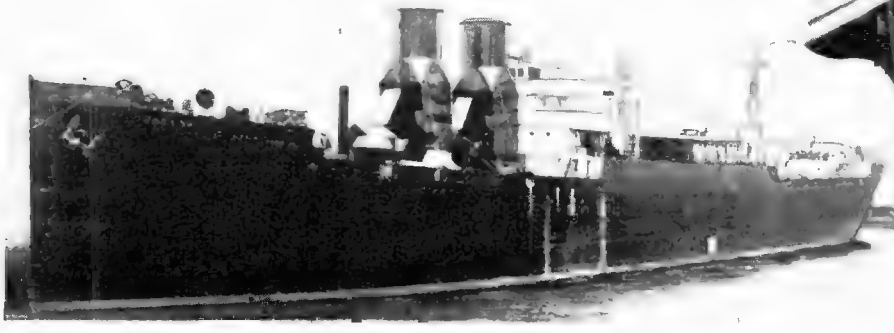
THE New England Public Service Company is trying to make sure that the regions it serves will never suffer an interruption in the supply of electric current which they require. There are going to be no tie-ups of industry because of insufficient water power, through drought or other catastrophe, and therefore lessened electrical current.

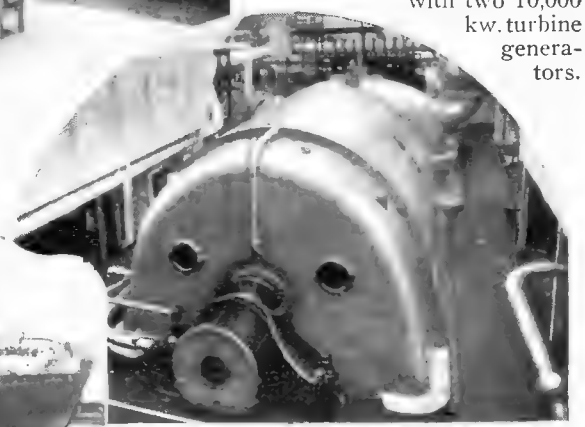
The organization whose headquarters are at Augusta, Maine, operates eighty generating stations in Maine, New Hampshire and Vermont. A few of these are steam plants, the majority are hydroelectric. In case of emergency, a floating power house, the power-supply ship *Jacona*, will be towed to the port nearest the affected area and connected to the line, to supply power until conditions return to normal.

The generators are arranged for 11,000 volt "Y," or 6,600 volts delta, which permits of a rapid tie-in at any point desired. The switch room, located in the after cargo hold space, contains the low voltage switches. The control panels for the entire electrical system as well as the communication devices necessary, are located there. The transformers are below.

The floating power house is equipped with two 10,000 kw. turbine generators.

Directly above is the switchroom of the "Jacona," showing the control panels and operation desk. Below, to the left, is the "Jacona" at anchor.





Here is one of the two 10,000 kw. turbines, that run at 3,600 revolutions per minute, which will generate power for the "Jacona."

Hot Steam from Wells

IN order to obtain natural steam, boring operations have been extensively carried on at Larderello, Italy. Recently a deep well was dug; the result was an upheaval of dirt, stones and gas. The eruption created a terrific noise that could be heard within a ten-mile radius.

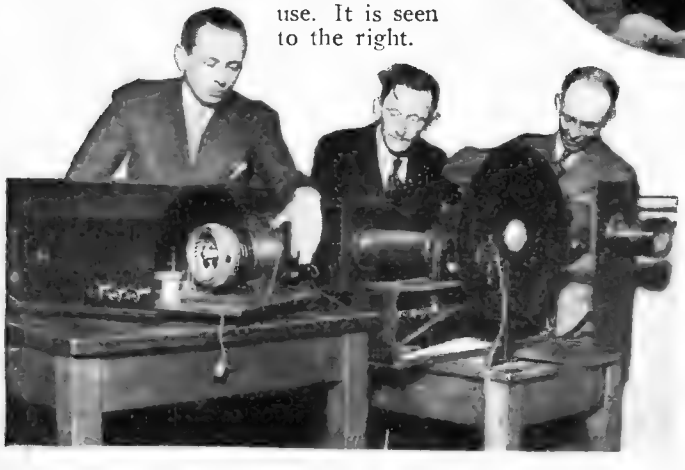
Engineers are attempting to find some means of governing the steam discharge so that its flow may be regulated and put to some commercial use, as has been attempted near the summit of Mt. Vesuvius.

Here we have a view of the well, with thick clouds of smoke escaping.

New Television Transmitter

AT this year's exhibit of the Council of the Television Society of London, held at University College, London, Captain R. G. Wilson, one of the members, demonstrated his new scanning mechanism, which he calls a *Prismascope*. This consists essentially of a motor-driven drum around the periphery of which are mounted a series of prisms whose angles progressively vary. When a beam of light is directed against the revolving prisms, it is reflected and scans the object to be transmitted or received.

One of the advantages of this apparatus is its small size compared with that of the normal disc scanner now in use. It is seen to the right.



Left—We see Captain R. G. Wilson with his new television apparatus for transmitting and receiving.

Meteor Paralyzes Electric Supply

METEORS have always held man's interest, both because of their threatening, dangerous characteristics and spectacular effects. Here is one that combined these features and was still more remarkable because of its unique appearance. This fragment of a meteor tied up the electric service of Herman, Neb., for several hours on the night of April 15th, until repairmen could splice the main power transmission line it broke.

Raymond Christensen of Herman, Neb., is standing in the hole created by the impact of the meteor fragment he is holding.

Diver Hunts for Cannibalistic Trout

"WHEN we go fishing, we'd like to catch fish," so the members of the Rainbow Angling Club in Azusa, Cal., said. And that's why they hired a deep sea diver, Jim "Sailor" Brown, to rid their favorite fishing grounds of cannibalistically inclined trout that devoured brother trout.

Jim "Sailor" Brown went beneath the surface, wearing the helmet we see him with. The bubbles escaping from it attracted the fish, which he caught in a net. He's got two trout in his hand, exactly the same age to a day. The larger one turned cannibal; his abnormal diet accounts for his size.

The offending trout were killed, washed, cooked and eaten.

Starch from Sweet Potato Culls

A PROCESS for making starch from sweet potato culls (inferior grade potatoes) has been perfected, according to a report of the U. S. Department of Agriculture.

"The sweet potato," says the report, "is the second largest vegetable crop grown in the United States, the Irish potato holding first position. It has been estimated that 10 to 30 per cent of the sweet potato crop is graded as culls, owing to the rigid requirements for market potatoes. These are now wasted or inadequately utilized.

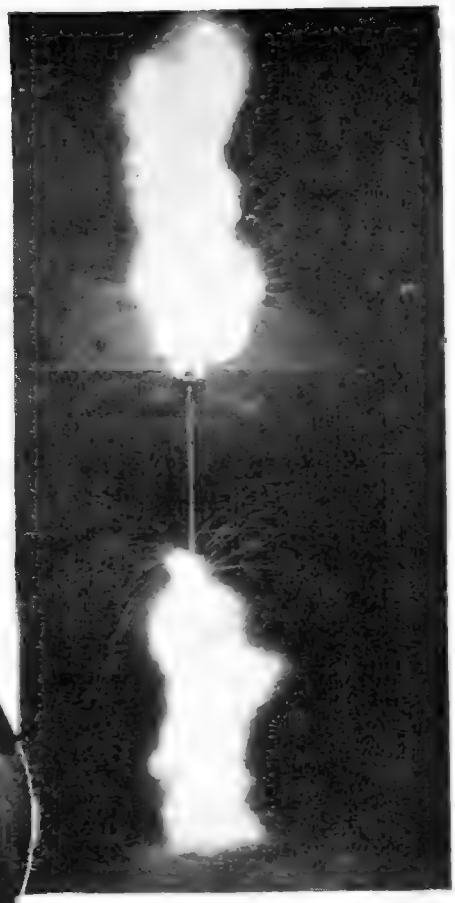
"A process has been devised for manufacturing starch from these culls, where objectionable color can be largely eliminated from the product, regardless of the tints of the potato flesh. The method involves the use of sulphur dioxide in the water used in grinding the potatoes. The treatment apparently keeps the pigments carried by the starch in a reduced form until they are extracted later in the process by a dilute sodium hydroxide solution."

Attention has been given to the utilization of the starch factory by-products as a feed for stock.

Synthetic Lightning Bolt of 132 Million Volt-amperes

ENGINEERS recently shot enough electricity through an experimental lightning rod to lift the Woolworth Building off its base in less than 1/500 of a second! The giant "spark plug" at the new Westinghouse high power laboratory blazed into action for the first time when over 132 million volt-amperes leaped across the terminals to the lightning rod on test. There was a burst of flame from each end of the rod, and the report sounded like that of a six-inch cannon, as the rod knocked out the terrific lightning bolt.

"The results of the tests are so promising," said J. J. Torok, Westinghouse lightning investigator and inventor of the rod, "that we are working night and day to finish its development as rapidly as possible."



"We hope it will affect greater economies in present forms of flashover protective devices now in service; to protect insulator strings on the overhead transmission lines which supply cities with light and power. In addition, it is expected to provide permanent protection against the ravages of lightning and save the country millions of dollars a year."

The device, technically known as a "De-Ion" lightning protector, is used to protect insulator strings on transmission lines against flashover. It makes replacements unnecessary and eliminates the patrolling of lines.

Auto Carrier Bears 100-Ton Burden

THIS truck will carry a load of 100 tons. It is the Scammell transporter, which has 14 wheels, 12 of these being mounted in pairs on relatively short axles. Each axle can oscillate to conform to the contour of the road. The carrier is attached to the tractor by a single ball and socket joint and "swan-neck." The wheelbase of the carrier is 40 feet long; to assist head clearance in passing under bridges the centre of the carrier can be depressed hydraulically 9 inches. The rear wheels can be steered independently from the back platform, from which the operator can communicate with the driver.

Coin Controlled Automatic Salesmen

AUTOMATIC merchandising in many retail lines of business is made possible by means of a new coin-controlled mechanism, which is adjustable to respond to only the exact price in coins made up of quarters, nickels and pennies, all inserted in one slot. Every price can be arrived at in two ways by properly setting the apparatus. In other words, should the goods cost nine cents, the price can be made up either with nine pennies or a nickel and four pennies. Properly set, the machine will receive either combination of coins and deliver your product. Numerous three-way settings may also be secured for articles whose price is quite high, in which your chances of making change vary.

The machine will operate to deliver an article for more than the price it is set for; but never for less. All coins inserted contrary to instructions are automatically returned. For instance, if the price is 89 cents, the instructions might call for coins to be inserted in the following order: Three quarters, two nickels and four pennies. If the nickels or pennies are introduced before the quarters, the coins will pass out of the machine, back to the customer; after the three quarters are inserted, you may insert the nickels, and then the pennies. In all cases the largest coins must be inserted in the slot first then the next in value, down to pennies.—*Elmer E. Seidel.*

Star Temperature Study to Reveal Planetary Secrets

Here is Dr. Theodore Dunham, Jr., with the photo-electric cell amplifier he is building.

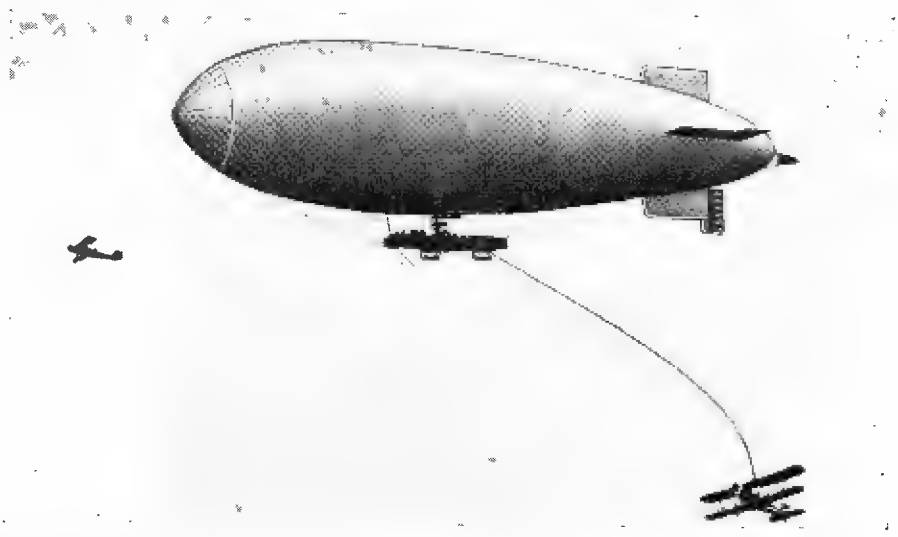
THE astronomers at the Mt. Wilson Observatory in California mean to wrest the secrets of the stars and planetary system from the high heavens. They will have the largest telescope in the world—a 200-inch mirrored instrument, and the most modern equipment extant to aid them in their researches.

Now Dr. Theodore Dunham, Jr., one of the scientists in the observatory, is very much interested in measuring the temperature of the stars accurately. He is building a photo-electric cell and amplifier combination that responds to light waves instead of radio waves.

Plane Delivers Mail via Blimp

USUALLY when mail is delivered from an airplane either the plane must make a landing or drop a parachute bearing the mail. The first method requires a landing field and takes a good deal of time that is very valuable in handling mail; the second method is too uncertain to be popular.

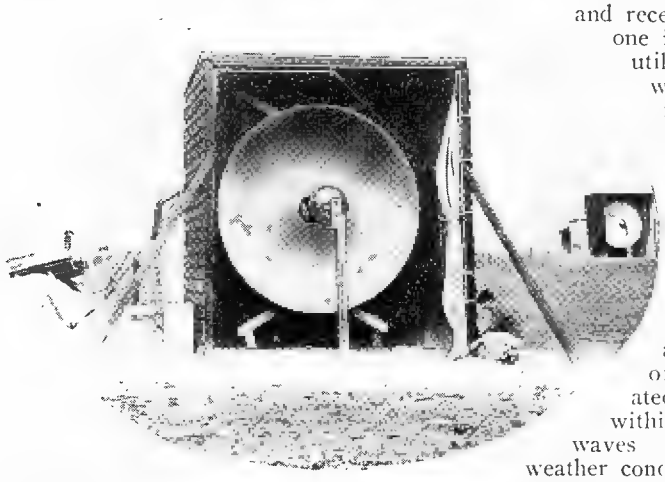
Now a new system is being tested in which mail is transferred in mid-air. An Army plane flew under a blimp. The blimp dangled a long rope. Occupants of the plane seized it and tied a mail bag to it. The bag was hoisted into the blimp, which was brought close to the earth so that it was able to deliver the bag to the ground station without effecting a landing.



Eighteen Centimeter Wavelengths Eliminate Radio Congestion

UNTIL a few years ago wavelengths under 100 metres were regarded as of no commercial value. Now the International Telephone and Telegraph Laboratories have successfully put through a two-way cross channel talk between Dover and Calais on an eighteen centimeter (about 7¼ inches) wavelength.

The aerials used for transmitting and receiving were less than one inch long, the power utilized was one half watt. The two-way radio telephone circuit produced a constant, clear reception. The reflectors which concentrated the rays into a fine beam were ten feet high. Tuning was so sharp that almost an unlimited number of sets could be operated simultaneously within a small area. The waves are unaffected by weather conditions.



Bleeding Aids Health of Blood Donors

BLOOD letting once used by doctors for the alleviation of almost every disease, may be said to have its benefits, according to studies which Drs. Harold W. Jones, Herbert Widing and Lyle Nelson have made on a number of donors of blood. So far as these donors were concerned blood transfusion meant merely the loss of a pint or less of blood. All the male subjects gained weight after the operation, the increase amounting to from one to thirteen pounds. Most experienced an unmistakable improvement in general health. Especially improved were cases of acne (pimples or blotches on the skin). Those suffering from constipation found this condition relieved by the blood loss. The donors, of course, were in fairly good health; blood letting might have had different results on persons actually ill. Just why this loss of blood should prove beneficial is not understood.

It is interesting to note that women make poorer blood donors than men, especially when a full pint of blood is taken from them. In these instances the return of the composition of the donor's blood stream to normal was delayed.

Tongues as Living Tin Mines

INSTEAD of silver tongued orators one should refer to tin tongued ones, according to Professor Gabriel Bertrand of Paris, who is well known for his researches into the presence and action of tiny quantities of copper, manganese and other metallic elements found in the organs of living creatures. He claims that the tongues of cattle and sheep contain nearly three times more metallic tin than is contained in any other part of these animals' bodies. Even so, the amount of tin is a few thousandths of one per cent.

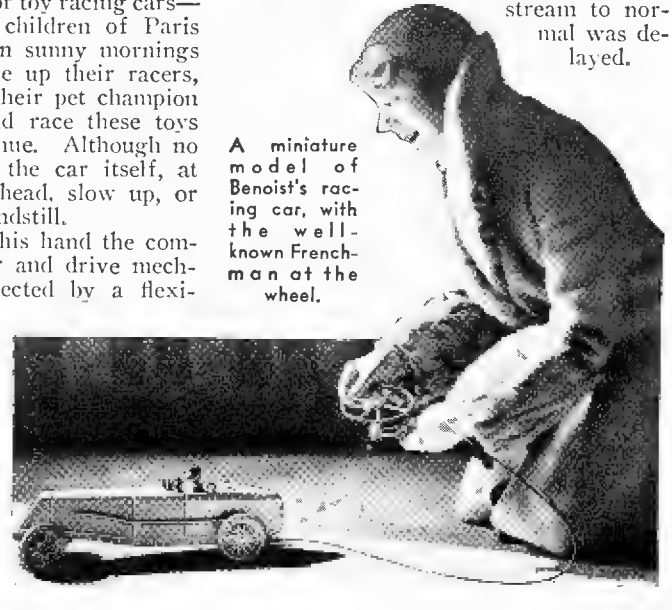
Previous investigations have shown Professor Bertrand that manganese is another element present in unusual amounts in animal tongues. Possibly both of these elements, tin and manganese, previously disregarded for their importance in the living organism, have something to do with the mechanism of taste, a sense the chemistry and true nature of which are still not understood.

Latest Mechanical Toy in Paris

REMOTE control for toy racing cars—that's what the children of Paris are going in for. On sunny mornings you can see them line up their racers, miniature models of their pet champion driver's speedster, and race these toys up and down the avenue. Although no human hand touches the car itself, at will the cars spurt ahead, slow up, or come to a sudden standstill.

The child holds in his hand the combination steering gear and drive mechanism which is connected by a flexible cable to the toy. He runs behind his automobile manipulating its speed.

The car pictured is a replica of the well known Delage superspeed motor car used by the racer, Benoist.

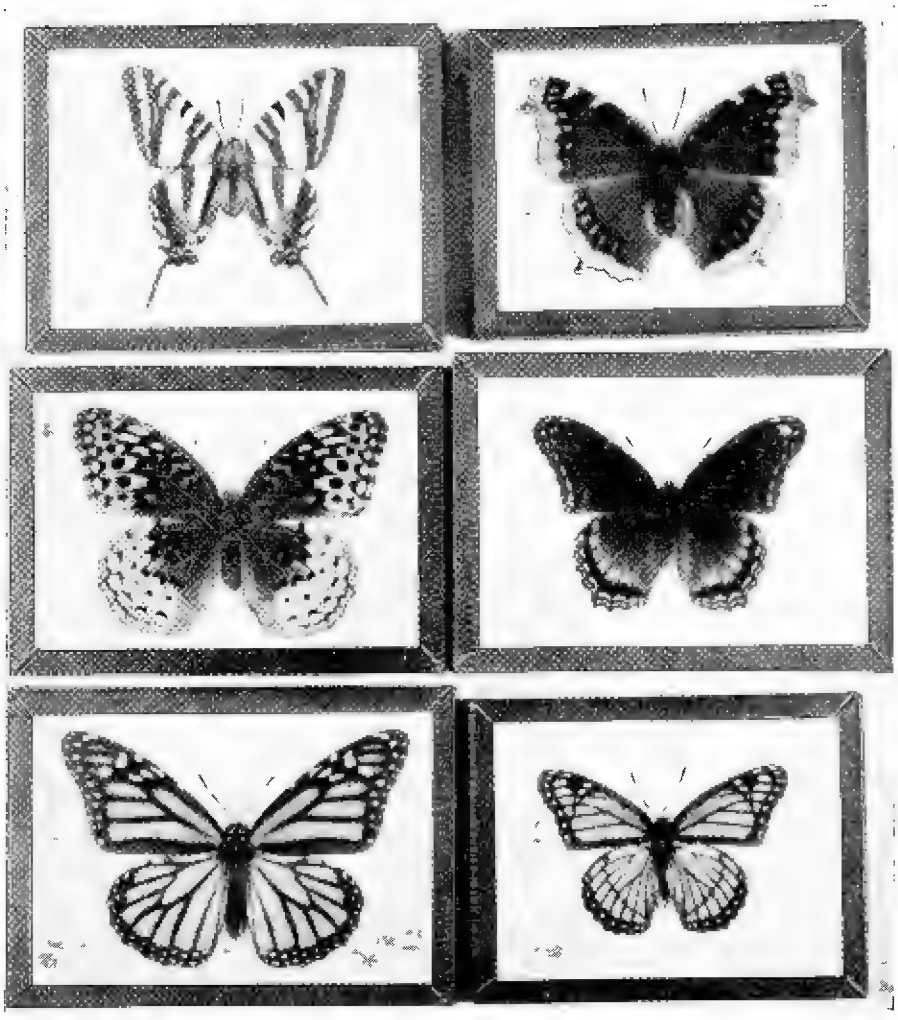


A miniature model of Benoist's racing car, with the well-known Frenchman at the wheel.

How to Preserve Butterflies and Moths

Easily Made Plaster of Paris Mounts for Butterflies and Moths Will Keep Your Best Specimens Free from the Ravages of Insects

By George A. Smith
Supervising Principal, Quarryville Borough Schools, Pa.



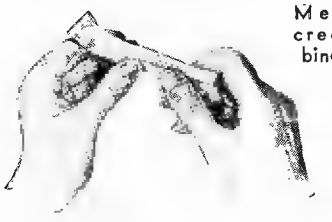
This is how butterflies and moths preserved in plaster of Paris mounts will look.

THE usual method of preserving butterflies and moths is to place them in glass-covered boxes containing cotton for a backing. This method is not so satisfactory because the specimens require considerable attention in order to keep them free from insect pests.

A better method of preserving butterflies and moths or even bugs is to be had by using plaster of Paris mounts. Mounts of this nature if carefully prepared will last indefinitely. They will provide a source of pride and interest for the collector and valuable aids to the nature student or teacher.

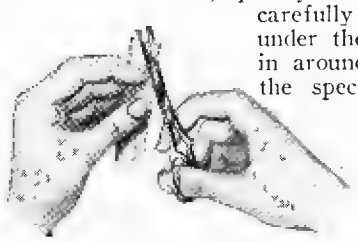
The collecting and mounting materials are simple and easily procured. You will need a collecting net and a poison bottle. The net can be made from a yard of green mosquito netting sewed in the shape of a bag having a depth of about eighteen inches and a circumference of about the same length. The net is supported by a heavy wire securely sewed to the rim of the net. One end of the wire is permitted to extend four feet from the rim of the net which serves as a handle. Bend over six inches of the wire at the end of the handle for a grip.

The poison bottle is made from a quart size fruit jar with a screw top. Place in the jar a lump of potassium



Method of creasing the binding tape.

or sodium cyanide the size of a hickory nut. The cyanide can be purchased at any drug store for a few cents. Cover the cyanide in the bottom of the jar with a mixture of plaster of Paris and water. After the plaster of Paris has "set" place over it a piece of perforated paper. This can be removed when soiled by captured specimens. The poison jar is now ready for use.



Cutting the corners of the tape for two sides of the mount.

Here are just a few suggestions about collecting specimens. Take the net and poison bottle and visit a nearby clover field in full bloom. The superb beauty and splendor there will be at your disposal. Gently approach a specimen that is feasting on the clover nectar, quickly cover it with the net, carefully place the poison jar under the net, close the net in around the jar and force the specimen into the jar. Screw on the lid and this beautiful bit of nature is yours. The dead specimens should be transferred to another container. An empty cigar box serves this purpose very well.

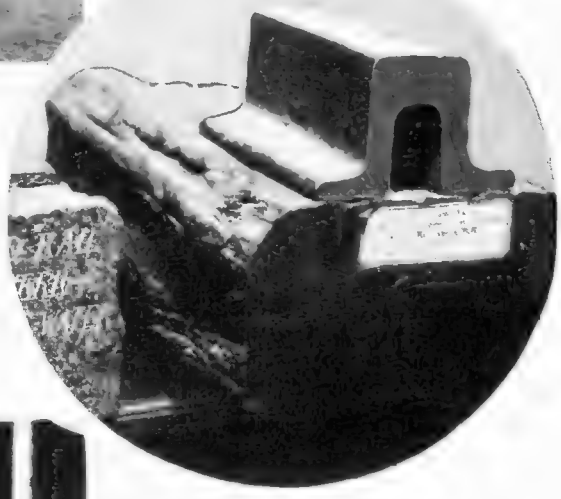
The next materials necessary are a drying board, a supply of common pins and small squares of glass large enough to cover the extended wings of the specimens. The squares of glass may be cut from broken pieces of window panes. The edges of the glass should be rubbed with a whetstone. The drying board is made from a soft pine board and should be at least three quarters of an inch thick, six inches wide and twelve inches long. A groove is cut in the board lengthwise through the center. The groove must be large enough to receive the bodies of the specimens. It is best to prepare several boards with different size grooves. A half-round gouge may be used in cutting out the grooves.

You are now ready to pin out the collected specimens. Pour them out on a paper and proceed as follows: Place a pin through the thorax of a specimen and place it in the groove of a drying board. Securely fasten it by forcing the pin into (*Continued on page* 333)

Runaway Auto Wrecks Three-Story Building

AN automobile driver lost control of his car. It ran into a hydrant, breaking the water main. As a result a nearby three story dwelling was demolished within a few minutes, as can be seen. The building was supported by posts over a ravine. The torrent of water rushing from the broken hydrant undermined the house completely.—*R. A. Johnson*

Would You Believe It?



This Rooster's the Only One of Its Kind

COMPARE this species of barnyard fowl with the ordinary chanticleer—there's a world of difference. And it is mainly because this extraordinary black feathered rooster grew a twenty-two foot tail. Just notice how its length exceeds the height of the man alongside it. The fowl is worth $15,000 and hails from Japan.

This black-feathered rooster is worth $15,000. It's all because of his twenty-two-foot tail.

First Rail in Our Railroads

HERE is a section of a lignumvitæ (the hardest of woods) tie used by the French in constructing the Panama R. R. It was necessary to bore holes in this tie for the spikes owing to hardness. To the left a small section of granite sleeper and iron rail used to build the first railroad in United States.

This Lady Can Write!

NO one can doubt Miss Thea Alba's ability to write—she puts ambidextrous people to shame. This charming young woman has trained herself so that she is able to use each of her ten fingers to write with, individually, and simultaneously. Then she can write with each hand, and with each foot, too, at the same time, so that she could make four different figures or letters while we struggle along with one.

Have you any WOULD YOU BELIEVE IT photographs? We will pay five dollars for every photograph accepted and published on this page. Send them in to the Editor.

Curing Rheumatism?

FAITH is the world's most powerful medium, so perhaps the aged Japanese woman who is stroking the holy bronze bull in one of the parks of Kyoto, Japan, will be relieved of her rheumatic twinges. The old Japanese still cling to the teachings of their fathers. According to legends handed down from one generation to another, there is nothing more efficacious for curing this malady than stroking the flank of a holy bull.

Modern medicine has left no impression on this Japanese.

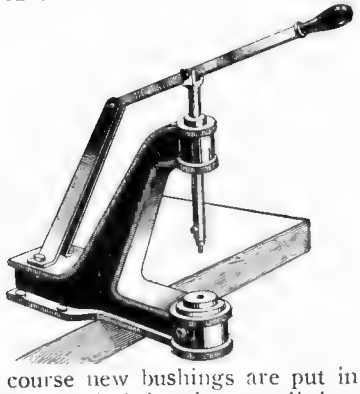
Wrinkles and Recipes

First Prize, $5.00

Auto Axle Makes Punch Press

THERE is a very good use for a section of the front axle of a junked car. That is the little bench punch press shown in the sketch.

The axle is cut off a short distance from the yoke, and the two spring bolt holes are left for the back braces or lever fulcrum arms as shown in the sketch. The yoke is fitted with a vertical arbor that is drilled and tapped on one end for the reception of the punches as shown and the top end is fitted with a brake rod yoke from a truck brake rod. The bottom section of the axle yoke is then fitted with a set screw, and round dies made to sit in it as shown.



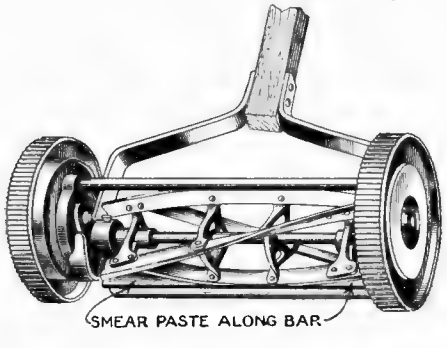
Of course new bushings are put in the yoke. We find that for very little spare time and labor and from odd material we have an excellent bench punch, handy for hundreds of jobs from sheet metal to brake lining, etc.—*Chas. H. Wiley.*

Paste of Emery Powder and Hard Oil Is Handy

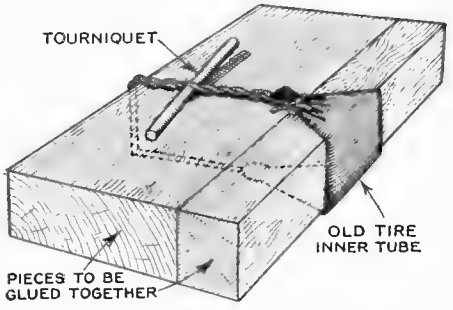
IT is sometimes necessary to use an abrasive. A paste of emery powder and hard oil is very helpful.

One place where the writer has used such a paste to advantage is in touching up the lawn mower. Here it is not practical to simply sharpen each knife, as the cylinder generated by the knives in turning must be perfect, for the machine to cut right. By tightening up the bar slightly, and then smearing the heavy paste mentioned on it in such a way that the mixture will be drawn in between knives and bar while turning the knives backward, one can put the mower in good shape for cutting.

—*John E. Hyler.*



Neat Substitute for Wide Clamp



JOBS in the home workshop often necessitate gluing in which wide clamps are needed. If none is handy, the makeshift illustrated is just as practical and satisfactory as the usual standard equipment. Pieces of old inner-tubing are laid across the parts to be glued. The ends of the rubber are tied tightly with a piece of stout rope. The rope can be twisted and a considerable amount of tension created with a small stick in much the same manner as a physician applies a tourniquet.—*Frank W. Bentley.*

Filling Cracks in Plaster Walls

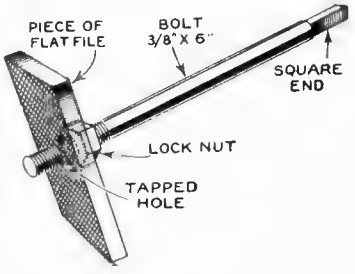
THE plaster walls of every house, no matter how well built and how carefully finished, eventually develop cracks. Too often the repairs that are made in these instances result in ugly looking patches which later fall out, making the spot look a good deal worse than it did before the repair was attempted. Here's a good way to make a mix that when once applied will stay put. The secret is that vinegar is to be used instead of water to mix the plaster of Paris. The mix will not set for about 30 minutes. Put into the cracks and smooth off and scrape away the surplus with a case knife.

$5.00 is paid each month for the Best Wrinkle or Recipe accepted and published in these columns. All others used are paid for at regular rates. Address: Editor, Wrinkles and Recipes.

Facing Up Pump Valve Seats

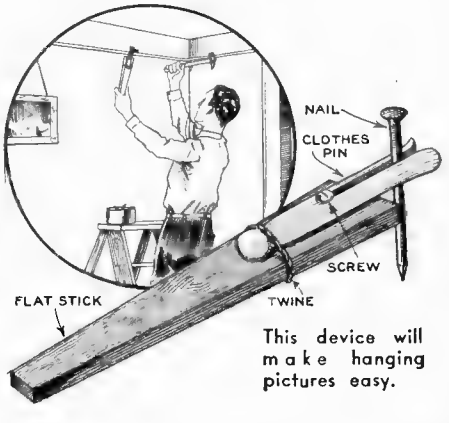
THE valve seats of a small pump were badly pitted and no grinding outfit was to be had. The following is a good remedy:

Anneal a flat file and cut a piece long enough to cover the seat of the valve to be ground. Drill and tap a hole in the center for a ⅜-in. bolt; then reheat and temper. Cut the head from a ⅜-in. bolt, about six inches long and square one end as shown. Run the bolt down through the piece of file about ⅜ of an inch to act as a guide while grinding. By placing this tool in a brace a neat job can be quickly done.—*R. C. Demary.*



Tack and Nail Holder

BATTERED fingers and broken nails are too often the rewards of the obliging gentleman who engages to hang pictures or nail that piece of furniture that needed attention for so long a time. Sometimes the difficulty lies in the fact that the nail must be placed in a location that is beyond his reach. In eliminating the possibility of this kind of work resulting in bruised digits and to enable the kind one to reach the high spots this very simple device is most effective. All you need is an old clothes-pin and a flat stick. Fasten the clothes-pin to the stick by a cord around the head and a screw in the crotch. In use, place your nail between the jaws of the clothes-pin and then you have a foot or two of extra reach depending upon the length of the stick.—*Louis Andrews.*



This device will make hanging pictures easy.

Your Summer Trips Made Trouble Free

Overhaul Your Car Now in the Manner Described Below, and You Will Be Practically Immune from Annoying Breakdowns During the Summer

By Arthur George
Consulting Engineer

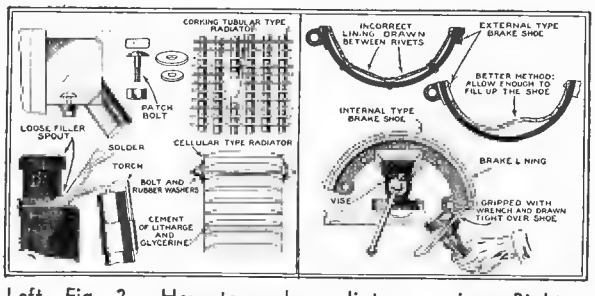
IF the automobile is properly gone over now, many of the usual troubles experienced at this season of the year are minimized or possibly avoided. The vital points to be adjusted, secured, lubricated or otherwise attended to are shown in Fig. 1. The radiator should be accorded a thorough cleaning, which is best done by disconnecting one of the lower hose clamps and allowing water to flow into the filler cap from a hose. The outside of the core should be just as carefully washed with a brush if it is clogged with dirt. Repack the pump and replace any hose that is peeled, cracked, or brittle.

The gasoline lines and tank should be cleaned by draining. If much sediment is drawn off, it is advisable to disconnect the main feed pipe and blow this out with compressed air. The commutator of the generator should be cleaned with fine sand paper on the end of a flat stick. The third brush should be adjusted until only 10 amperes register as the output. The distributor should be wiped out, drops of grease placed on the cam, and the contact points set to the correct distance.

The intake manifold and carburetor connections should be made absolutely tight. The transmission and differential cases should be drained and the same filled with heavy grease. Tighten up battery terminals, the battery clamps and examine the ground and main cable for breaks or shorting; replace if defective. Tighten up the universal joint flange bolts and the spring hanger bolts.

If the anti-freeze has eaten a hole through the radiator, if freezing has broken a tube, or if the wrench slips, the water jacket will soon be emptied. Emergency repairs are often required. Almost anything can prove of service, even a piece of chewing gum. Soldering is the most durable repairing job for the radiator. The methods shown in Fig. 2, are of use in making temporary and permanent repairs. They can be applied without removing the radiator. A tubular radiator with a leaking tube is repaired by cutting the tube above and below the break with a saw. Do not bend with pliers, as the tube will split further. Pieces of cork can be pushed in until it is possible to plug and solder.

A patch bolt with an elongated head can be used in the tank. A rubber washer makes an effective seal. Cellular radiators can be patched with rubber washers and a small bolt through the core. Litharge and glycerine as a cement can also be forced into the leaking cell. For a broken filler spout soldering is the only remedy. Use a small alcohol blow torch, clean the metal, heat well, and flow the solder around the joint with flux.



Left—Fig. 2. How to make radiator repairs. Right—Fig. 3. Both wrong and correct methods of brake relining are illustrated.

The importance of good brakes cannot be overemphasized. In emergencies these are the only safeguards against accidents and it is essential that they be dependable. Where brake linings are worn thin, so that the embedded brass wire is rubbing, relining is in order.

The removal of the shoes can usually be accomplished by taking off the wheel and taking out the retaining cotters and washers. A length of good lining of required width can be obtained from any accessory store, with rivets. The old lining can be torn off with heavy pliers and a sharp chisel will cut out the rivets. The illustration, Fig. 3, shows the important details with regard to placing the new lining on the shoes. In lining contracting brakes, avoid the mistake pictured by allowing surplus material as indicated in the correct method illustrated.

For expanding brakes draw the lining tight using a wrench as illustrated, after riveting one end. Drive all rivets solid, so that the lining cannot be loose, and the results will be all that is desired in the braking.

The time (*Continued on page* 351)

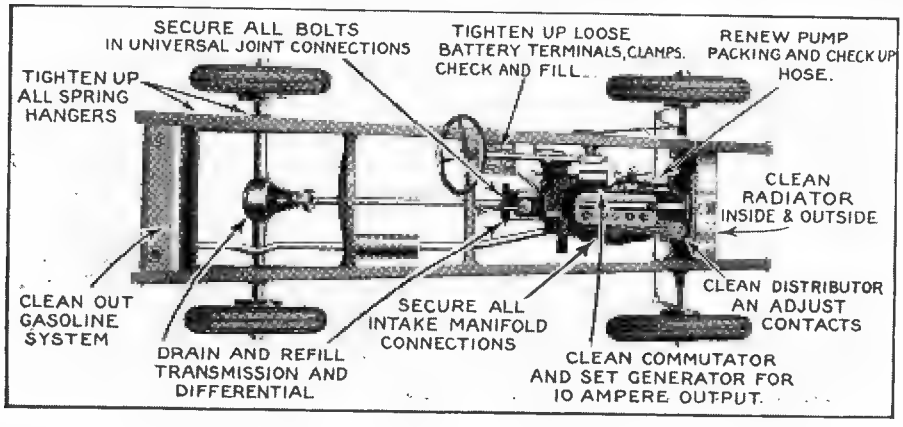

SECURE ALL BOLTS IN UNIVERSAL JOINT CONNECTIONS
TIGHTEN UP LOOSE BATTERY TERMINALS, CLAMPS. CHECK AND FILL.
RENEW PUMP PACKING AND CHECK UP HOSE.
TIGHTEN UP ALL SPRING HANGERS
CLEAN RADIATOR INSIDE & OUTSIDE
CLEAN OUT GASOLINE SYSTEM
SECURE ALL INTAKE MANIFOLD CONNECTIONS
CLEAN DISTRIBUTOR AN ADJUST CONTACTS
DRAIN AND REFILL TRANSMISSION AND DIFFERENTIAL
CLEAN COMMUTATOR AND SET GENERATOR FOR 10 AMPERE OUTPUT.

Fig. 1. The time spent checking over these points will be well repaid by the money saved in repairs later on.

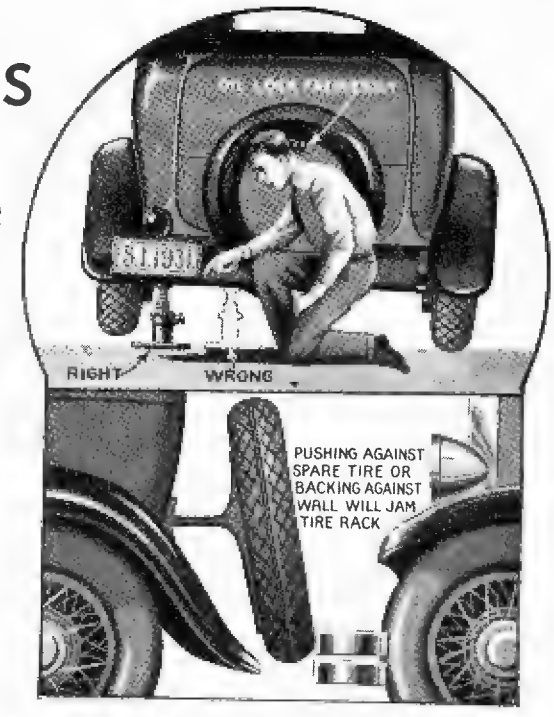


Fig. 4. Place your jack as closely as possible to the wheel you are lifting. Fig. 5. What not to do to your spare tire.

Scientific Aids to Your Comfort

A Home Is As Pleasing and Livable as Its Household Equipment. Watch This Page for New Items That Will Make Yours More Attractive

By Mary Jacobs

Smoking Stand Combination

IT'S quite a nuisance to get up from a comfortable chair and search for matches when your pocket lighter does not respond to energetic thumb motions. And after you have lit your cigar or cigarette, the chances are that an ash tray will not be near, and you will have to get up again. . . .

How much more convenient to have one of these automatic electric combination lighters and ash trays at your side, scientifically proportioned so that you need hardly shift your position to reach for the featherweight torch. Lift it from its receptacle, touch to the spark gap, instantly a smokeless, odorless flame is ready to light your cigar, cigarette or pipe. Returning the torch to its receptacle snuffs out the flame.

The attractive appearance of the smoking stand makes it an asset to your living room. Surmounting the black lacquered surface is a chromium-plated top, which contains the service parts. Tested and approved in our laboratory.

One Speaker at a Time

"HOLD the wire a minute while I turn off the radio," will be passé after you have installed this device for automatically shutting off the loud speaker when you pick up the telephone receiver. Gone also will be the impatient, annoying wait for the tubes to heat up again after you have finished your phone conversation. It's the loud speaker only, and not the radio, that has been switched off.

The item is very reasonably priced, and can be installed easily. It is finished in smooth black to match the phone, and can be obtained for either the old standing type or a French type instrument. Tested and approved in our laboratory.

Giving Yourself an Ice Pack

THAT pleasant, soothing feeling that only an ice pack brings is too often accompanied by uncomfortable, messy tricklings of melting ice, when you try to give yourself this beauty treatment at home.

Here is a new development that makes ice packs as pleasant as they are beneficial. A large metal spoon with a pretty handle does the trick. It is coated with a non-tarnishable chromium plating, and contains a refrigerant liquid hermetically sealed within its ball. All one need do is massage her face with such a spoon, which has been kept in the refrigerator to attain a very low temperature. Tested and approved.

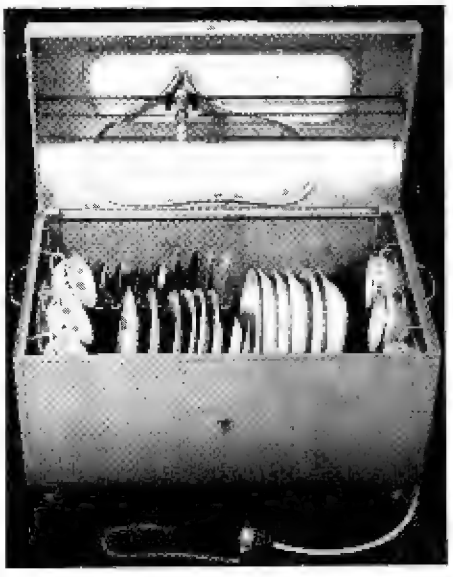
Dishwashing Made Easy

MOST housewives agree that washing dishes is the nearest approach to drudgery in their daily routine. Yet at least once a day, plates and saucers, cups and cutlery must be cleansed. Of course, a good electric dishwasher relieves the monotony of the task, and makes it almost pleasant. But there are many families which are not in a position to purchase electric machines.

For them the dishwasher pictured is ideal. It utilizes a water motor, not an electric one. The machine, which is portable, fits on the drain board of the sink and operates from the faucet. Soap is placed in a container attached to the hot water faucet. A stream of water is forcibly ejected upon the dishes; the motor causes this stream to oscillate so that though the dishes remain stationary the movable jet of water plays upon all of them with equal force. The mechanism works rapidly; less than half a minute is required to wash the dishes when the dishwasher is full.

The equipment is enameled and when closed resembles a large bread box. Of course, it can be stored under the sink when not in use. There are compartments to accommodate 18 dishes, 6 cups and 40 pieces of cutlery. Each of the 20 holders for knives and forks and spoons has room for 2 of these pieces. Tested and approved in our laboratory.

(*Continued on page* 347)



Names and Addresses of Manufacturers Furnished Upon Request

MAGIC

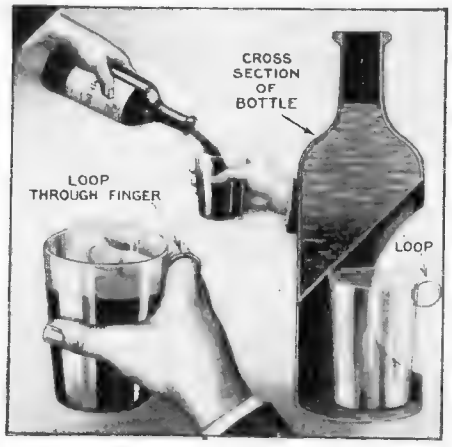
By Thurninger

The master mind of modern mystery, who has mystified Ex-presidents Harding, Taft, Roosevelt, Coolidge, the Prince of Wales and other celebrities, presents another of his magic series.

Ghost Writing

A SMALL blackboard, about twelve by fourteen inches, is passed for inspection. Upon its return it is suspended by means of two ribbons hanging from the fly about five feet above stage level. Upon request various spectators call number combinations of four digits, which the performer chalks upon the slate. After four sets of numbers have been called an assistant appears who hands the performer a ruler with which the latter draws a chalk line beneath the figures. Standing at some distance from the blackboard the performer fires a shot, and instantaneously without covering, the total to the rows of figures appears mysteriously upon the blackboard. Upon inspection, the addition proves to be quite accurate.

An off-stage assistant, concealed in the wings, hears the numbers as they are called, and pencils them down upon a small pad. He quickly adds them up and writes the total upon a hinged silicate flap, which he then folds, and conceals in back of the ruler; he brings the ruler and flap forward and hands them to the wizard. In the act of drawing a chalk line, aided by the ruler, the magician secretly attaches the folded flap beneath the figures by two thumb tacks affixed to opposite ends of the flap.



As the shot is fired, the off stage assistant pulls a thread to which has been tied a clip that holds the flap in place until the appearance of the numbers is required.

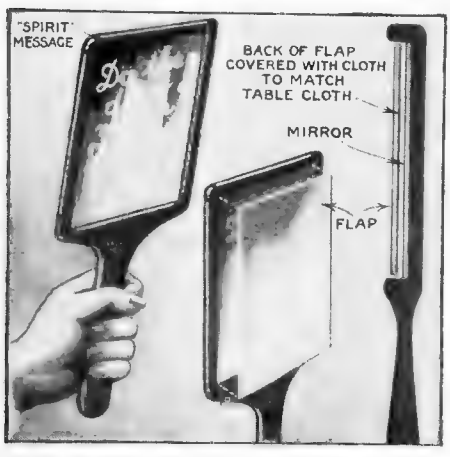
The Spirited Mirror

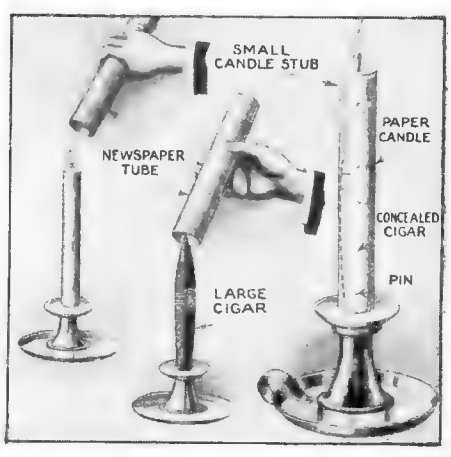
CONJURERS and bogus spirit mediums have for years been using flap slates for producing spirit messages. Here is a brand new idea of apparently producing a spook sentence from the other world.

The face of a hand mirror is wiped to prove the absence of chemicals. It is then placed in a paper bag, and given to some spectator to hold. After the usual array of mystic acting the mirror is drawn from its paper covering, and a spook message written in white crayon is discovered upon the looking-glass.

The wizard employs a flap of thin mirror glass, cut to size, to fit loosely in the frame of the mirror proper. Beneath this flap, the message to later appear has been written beforehand. After the mirror has been shown, it is placed face downward upon the table, while the magician directs attention to the paper bag. The mirror is now lifted from the table, its back toward the audience, and placed in the bag, leaving the flap upon the table. As the back of the flap has been previously covered with cloth to correspond in color and design with the table top proper, it is not observed. The wizard

(*Continued on page 327*)





No. 95 of a series of articles on magic appearing monthly

Iron-Banding a Box with Linoleum Strips

Scraps of Wood and Linoleum Will Enable You to Fashion This Practical Wood-Box for Your Fireplace. The Ornamental Strips of Linoleum, Properly Treated, Appear to Be Wrought Iron

By Edwin M. Love

The completed wood-box is an ornament to any living room.

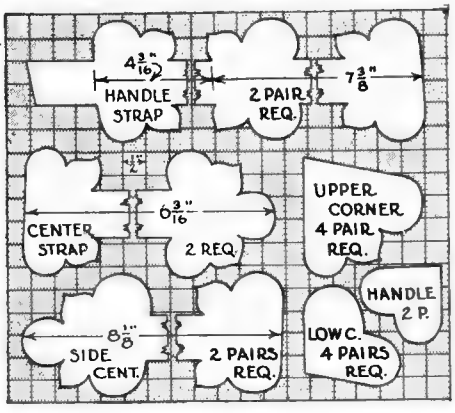
WHY not build your own fireplace wood-box of slabs of wood and pieces of linoleum? Peened, studded with upholstery nails, and painted black, the ornamental straps so closely imitate wrought iron as to deceive anyone, except under close inspection.

Because it is light, and its grain is well adapted to the weathered finish given the box, cypress is first choice for wood; but fir is nearly as good. For the slab effect, and to lessen warping, use two or more pieces of random widths to make each side and end.

Dowel the pieces together. Lay edge to edge enough pieces to make the width of a side, and mark across the faces several times with a pencil, thus identifying the set. Joint the edges. Fold two slabs together, face sides out and joint edges up, clamp them in a vise, and square lines across three points, one in the middle, the others near the ends. Set a marking gauge for half the thickness, and score lines across the others, using the guide against the face sides. If the centers are prick-punched, the bit point can be placed more accurately. Bore ⅜-in. dowel holes in 1 in. deep.

To emphasize the wood joints, chamfer the face corners of the joining edges. A couple of light cuts on each, made with a power joiner having the fence set at 45 degrees, are sufficient, although of course a few strokes with a hand plane will do the work.

When gluing-up, be sure to apply adhesive to all joining surfaces. Since the box may be called upon to hold wet wood occasionally, it is well to use a moisture-resistant cement, such as casein glue. Assemble stock for two sides at a time, using a clamp on each side and such wedges between the wood and the clamp bars as are needed to keep the stock flat, not forgetting to use blocks under the jaws to prevent crushing of the edges outside. Clean off all squeezed-out glue with a cloth dampened with warm water.



First cut cardboard patterns for the linoleum pieces which are to serve as iron strappings.

Rip the sides and ends 11½ in. wide. Square lines across the ends for the top lengths, and measure in 2¼ in. from these to determine the slope of the ends. If a power saw is used, set the miter gauge by holding the blade of a framing square against it, adjusting the head until the 2¼-in. point of the blade and the 11½-in. line of the tongue lie on the same side of the guide groove in the table. Cut one end of the four pieces according to this setting, and reset by the degree marks for the other ends.

Simply butt-nail the ends between the sides, having sized the ends and glued all joining parts.

The bottom fits inside. Be sure to lay out the bottom dimensions on the lower side, or the piece will be about ⅜ of an inch too small. Glue and nail this also.

The handles are hardwood, secured to the box ends with lag screws through the ends and the side parts.

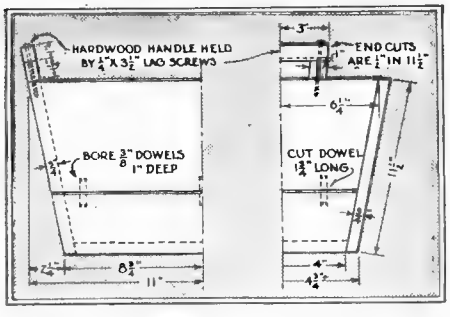
If a blow torch is at hand, scorch the box all over the outside, and scour off the charred material with a stiff wire brush. If no torch is available, nearly as good results are obtained by rubbing the wood with the brush until the hard grain is brought into relief.

Save time on the "iron" work by cutting all pieces before attaching them. Lay out full-sized patterns on cardboard for each strap and corner "iron," cut them out, and trace on the back of the linoleum. Turn them upside down for one of a pair. Tin snips are convenient for cutting the leaf parts in linoleum, but a wide chisel is best for the straight sections between.

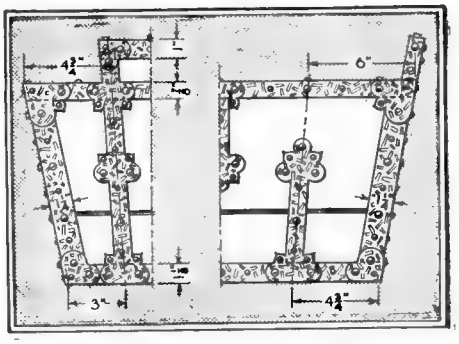
Attach the upper and lower straps first. Spread glue on the painted side of the linoleum, press smoothly in place, and secure with a brad at each end and one in the middle. The corner joints need not be closed perfectly since they are covered. Keep the edges flush with the top and bottom of the box. Butt the corner straps between, gluing the end ones first, and lapping the side irons over them, to give the appearance of angle irons.

Miter strips of linoleum around the upper edges, covering as well the ends of the handles.

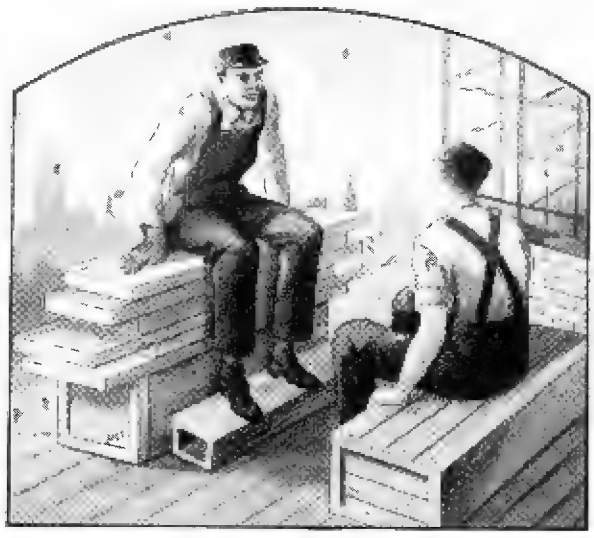
Draw center lines for the handle and inner side straps, attach these irons, and fit the corner clips, making neat joints, as though the (*Continued on page* 349)



Constructional details of the handles and position of the dowels.



The "iron" bands. Note the upholstery nails which stud the straps.



Prize Puzzles to Polish Your Wits

By Sam Loyd

THE Puzzle King presents the twentieth of a series of problems, the solving of which will show if your mathematical ability is bolstered up by logical reasoning. Prize winners of the May puzzles and solutions will be found on page 351.

TWENTY-FIVE DOLLARS IN PRIZES

A FIRST PRIZE of $10 will be awarded to the person sending correct answers to the four puzzles accompanied by the best expressed analyses.

A SECOND PRIZE of $5 will be awarded for the next best analyses and correct answers to the four puzzles.

TEN PRIZES of $1 each will be awarded to the ten persons who send the next best analyses and correct answers to the four puzzles.

Answers must be received not later than noon, August 16, addressed to "Puzzle Editor," SCIENCE AND INVENTION, 381 Fourth Avenue, New York City.

All contestants must abide by the decisions of Sam Loyd, who will examine all papers and award the prizes.

Papers of identical merit, tying for any one of the prizes, will each receive the full amount of the prize tied for.

Puzzling Wages

THREE mechanics whose wages, in keeping with their abilities, were unalike, started together on a job which, when finished, brought them collectively $598.

The work was completed in forty-five days, and Jones and Brown labored from start to finish. Robinson, the third man, quit after working only two days.

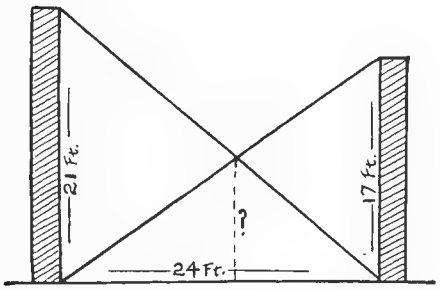
Jones, the best worker of the three, received $315 for his 45 days' labor, and Brown, after adding up his receipts, remarked to Jones:

"If you and I had done this job without any assistance from Robinson, I would have earned $6 more."

If Brown's statement is correct, assuming that he and Jones would have split Robinson's two days' pay in the same ratio as their respective daily wages, who can tell how much each of the three men received of that $598?

An Aerial Puzzle

HERE is a little problem that cropped out while we were setting up our radio aerials.



Having erected two poles, 21 feet and 17 feet in height and 24 feet apart, we braced them by stringing wires from tops to opposite bases, as shown in the sketch. Just how high from the roof floor is that point of intersection of the crossing wires?

The distance between poles is really not essential data.

Sweet Charity

THE Brown sisters were given $100 with which to "stock up" the candy table at the church charity bazaar. The girls paid 62 cents per box for chocolates, $1.02 for bonbons, and $1.34 for fruit glace. Then they priced their sweets so as to make 12 cents per box on the chocolates, 22 cents on the bonbons and 25 cents on the fruit glace.

Now, if they invested that $100 to the best possible advantage in the three kinds of candy, with the condition that they must purchase exactly 100 boxes, what was the largest profit they could have realized on a sell-out?

A Puzzle in the Ledger

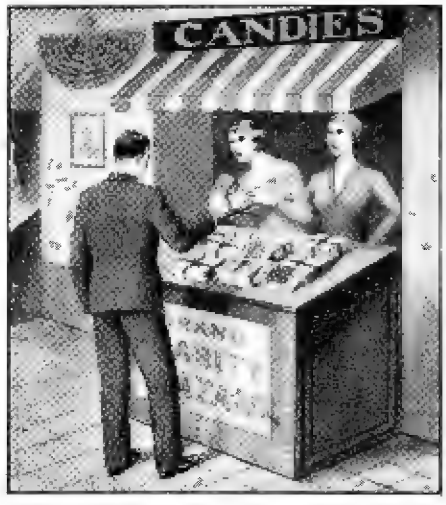
OCCASIONALLY correspondents call my attention to features in their business affairs which provide puzzle material. Following is an excerpt from such a letter:

"I would like to submit a mathematical oddity which I encountered at my office the other day. It seems that some material was purchased at list price, less 60 per cent., whereas the seller allowed us but 55 per cent.

"Experimentally, I deducted both discounts from the list price, and found that the net totals each consisted of the same four digits, of course in different rotation. Upon adding together these net amounts, I was further surprised to find that their sum contained the same four digits as did the original list price, in different rotation!

"The question is, of course—what is the list price? In vain, I have looked for two gross amounts that would fit the description. That list price appears to be a unique coincidence. Can you explain the matter?"

The correspondent's so-called coincidence is susceptible of mathematical analysis, and it is quite interesting. How would you go about discovering that list price number of dollars, composed of four digits?



This self-serving tray can be painted to harmonize with any setting you desire. Do not allow paint to enter the groove of the bearings, if you would have the tray turn easily.

A Revolving Self-Server for Your Table

Here Is a Device You Can Easily Build, in Which the Tray Rotates Easily and Smoothly

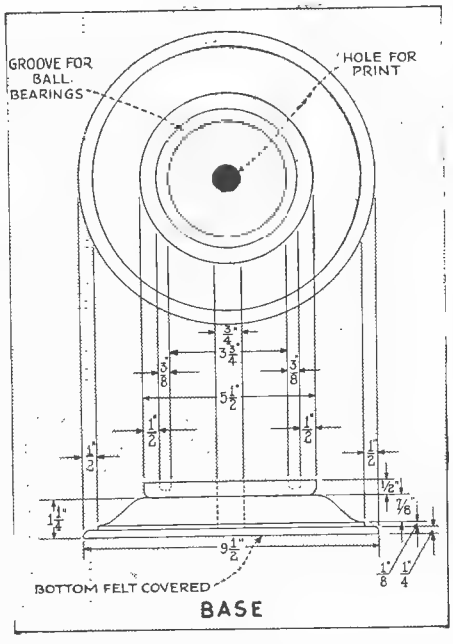
By Edwin T. Hamilton

HERE is a unique article which has many uses in the home. On the dining table, it eliminates that unsightly "boarding house reach"; at the tea table, the difficult feat of attempting to pass plates, while holding your own on your knee, is removed; and at the sick bed, by placing the server beside the bed, the patient can easily help himself.

Constructed in three parts, the base, pivot piece, and tray, it presents little difficulty to the man who has a lathe in his workshop. Mahogany is one of the woods which give the best appearance, but for the tea or breakfast table, or the sick bed, where the other furniture is painted, any wood, finished in pretty colors, will answer perfectly.

The base is turned up first. Obtain stock measuring 1¾" thick and 10" square. Locate the face center, place in lathe, and turn to a diameter of 9½". The lathe is now stopped, and the diameter lines are located while the work is off the lathe. On one of the faces of the stock, measure the following distances from its center, ⅜", 1⅞", 2¼", 2¾", and 4¼", marking each point clearly with a pencil.

The height lines are now located along the side of the stock. From the face on which the diameter lines were located, mark off the following heights, ½", ⅞", ⅛", and ¼", which total the 1¾" thickness of the stock. The work is to be replaced in the lathe. While running the lathe slowly, place

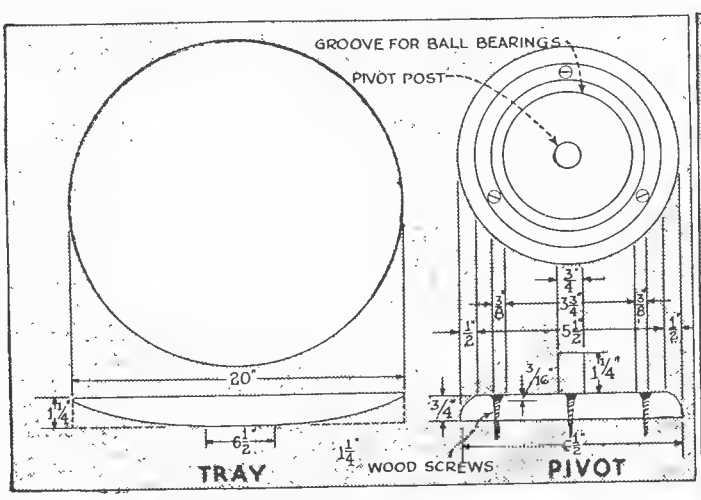


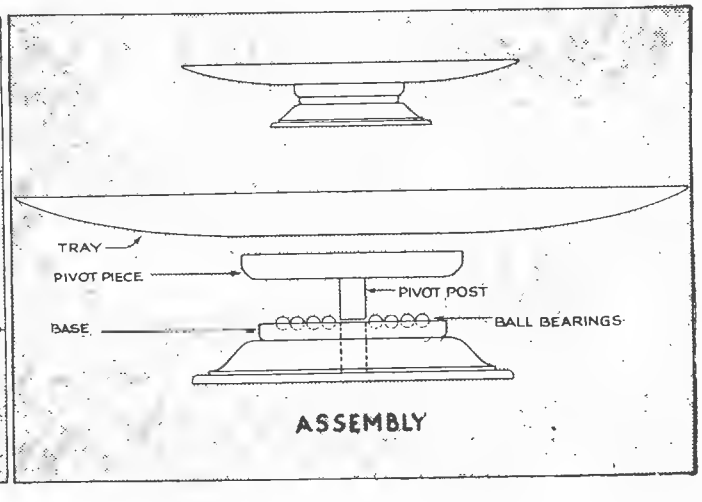
the point of your pencil against the marks just located on both the side and the face, and hold it there until each circle appears clearly. The base is now turned up as shown in the base plan. While still in the lathe, finish smooth with sandpaper, taking care not to blunt or disfigure in any way the design's outline. The work is now removed from the lathe.

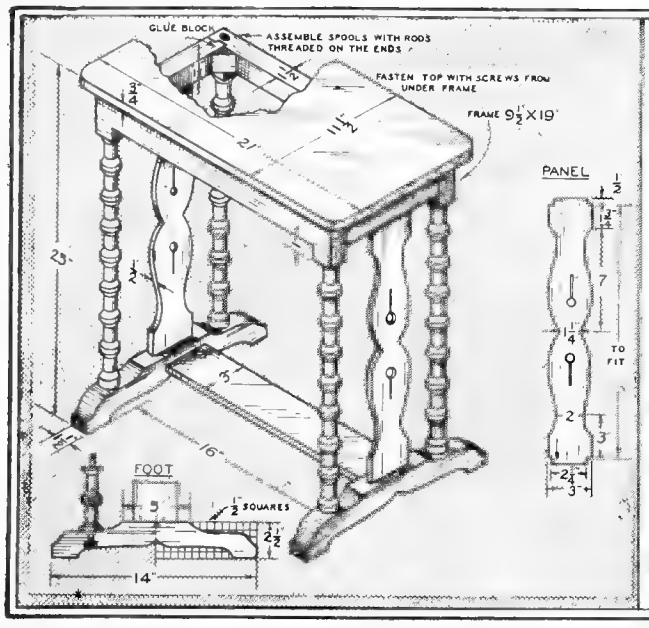
Using a ¾" bit, a hole is now bored 1½" deep into the center of the base. Start the hole in the center of the first diameter circle drawn.

The groove in the base accommodating the ball bearings is next cut. The second and third circles from the center, drawn on the face, represent the inner and outer edge of this groove. It is ⅜" wide, while its depth should be 3/16". The ball bearings used are ⅜" in diameter, and as the base groove is only half of the entire bearing runway, it must be cut only half as deep as the diameter of the balls. The remaining half of this runway is cut in the pivot piece.

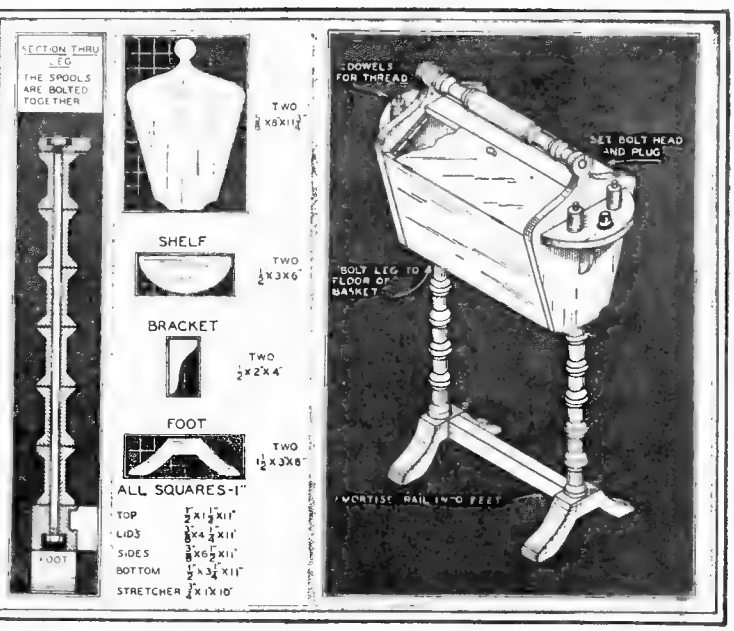
The pivot piece is then turned up. Obtaining stock 2" in thickness and 7" square, locate its face center, place in the lathe, and turn to a 6½" diameter. The work is now removed, and the diameter lines are located on one of its faces. From the dead center of the face, these measure ⅜", 1⅞", 2¼", and 2¾" out toward its edge. Note that these measurements are the same as for the (*Continued on page* 342)







Full details for the construction of the table; about three dozen spools are needed.



The dimensions for this sewing basket will serve as a guide; they may be altered.

An End Table and Sewing Basket From Discarded Spools

Additional Tables, Particularly Ornamental Ones, Come in Handy . . . The Sewing Basket You Can Readily Make Will Be More than Appreciated by the Women of the Family

By H. L. Weatherby

Director of Manual Training, Montgomery County Schools, Montgomery, Ala.

LAST month we told you how discarded spools could be turned into beautiful corner and hanging shelves and magazine tables. This month we take up another table of an entirely different style and a sewing basket.

One can not have too many tables. The one illustrated with this article can be used to advantage as an end table, a table to place by one's easy chair; by the bedside; or anywhere a small, low table comes in handy. Like all furniture constructed from spools, when properly bolted together it is extremely sturdy and durable. Its fragile appearance is deceiving, it will stand a great deal of rough usage. The spools are of light-colored, clear-grained wood that will finish in almost any way one desires.

The construction of the table is not difficult, and when it is remembered that there are no legs to build (usually the most difficult part of a job of this sort) the rest looks and is easy enough. We would recommend that large spools two inches in length be secured if possible, the kind that might come from a drapery house. With about three dozen of these spools on hand (they can usually be had for the asking) construction operations can go on.

Patterns are laid out on paper for the panel and for the feet, the wood is cut to size and the top glued up, if necessary, to secure width. The drawing indicates the method by which the rail under the top is joined. Glue blocks are used on the inside corners to further strengthen these joints. Since the holes for the rods are bored at these corners, care must be taken not to cut in too deep for the rails, thereby weakening the structure.

The completed table, which may be used anywhere a small, low table is desired, is a good looking piece of furniture.

The feet and panel must be sawed to shape, by the paper patterns already prepared, the corners of the top rounded and the steel rods or bolts prepared for the legs. These rods should be threaded on each end to fit the nuts. Dies and die stocks can be purchased for a few cents from five and ten cent store tool departments; or the rods can be threaded at the time of purchase at the machine shop.

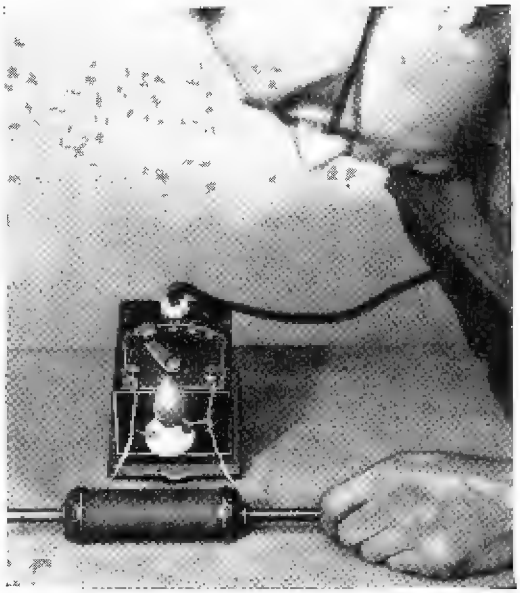
In preparation for boring the holes in the rails and feet, the parts to be bored should be placed together and the locations for the holes centered up exactly at top and bottom, otherwise a twisted table may result. After carefully boring the holes, and a thorough smoothing and sanding of all parts of the frame, the spools forming the legs are bolted to the frame, and the panel and stretcher are glued in position. When this has set, the top is fastened to the rails by means of screws from below, and the table is ready for the finish.

The sewing basket is one of the most useful articles around the home. Every woman needs something of this nature to keep her mending thread, needles, thimbles, and other sewing accessories. The one illustrated is patterned somewhat along (*Continued on page* 339)

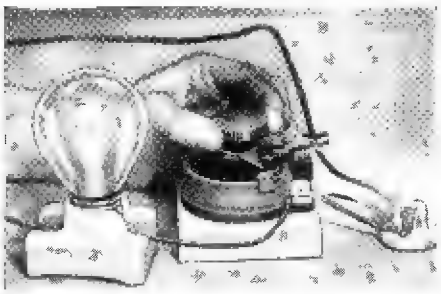
Electrical Principles from Easily Performed Experiments

An Electric Laboratory Is Not Needed to Master Some of the Basic Principles and Laws of Electricity . . . And You Will Derive a Great Deal of Enjoyment from Trying These Stunts

By Raymond B. Wailes



The alternating current flow to a device such as a lamp can be cut down if an iron rod is inserted into a hollow core coil included in the circuit.

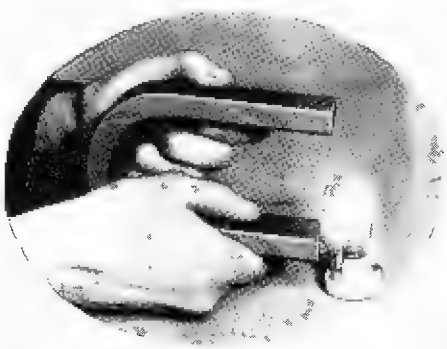


Here's how a 2½-volt flashlight lamp can be lit from a 110-volt lighting circuit. A radio potentiometer does the trick.

EQUIPPED with several small flashlight bulbs and sockets, a toy transformer, a coil of wire or two, and a bite from the electrical experimenter bug, one may learn some important electric principles which will, no doubt, not soon be forgotten. In the vernacular of a well known electrical trade school, one "learns by doing," in performing these experiments.

Motors, lamps, electrical heating devices, and other appliances "pull' or require more current at the moment they start than after they have been operating for several moments. Becoming warm after operating, the resistance of the device increases to such an extent that the current flow through them is automatically reduced. If a coil of small wire is placed in series with a battery and a flashlight lamp, the lamp will become dim if the coil of wire is heated with a flame, due to the resistance of the coil, greater when it is hot than when it is cold. One will need to heat several turns of the coil red hot in performing this simple experiment.

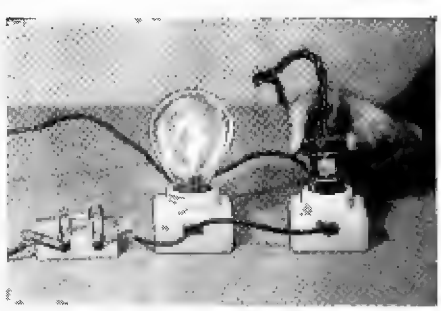
AC or DC? Meaning, alternating current or direct current? This question has been asked many times. If a small 110-volt lamp is lighted with the current in question, a horseshoe magnet held near the filament will cause it to vibrate if the current is alternating. If direct, the filament will simply lean toward or away from the magnet. As magnetic lines of force are set by every wire carrying a current, the magnet attracts the filament and repels many times a second, for, as the current is alternating, the magnetic field changes in polarity many times a second. It is best to use a lamp having a pig-tail filament for this experiment.



If a magnet is held near a lighted filament and vibrations of the filament can be observed, alternating current is flowing through the circuit.

When the current is broken, the lamp flashes up very brightly due to the current generated by the collapsing of the magnetic lines of force in the coil.

One may light a 2.5 volt flashlight bulb from the 110-volt circuit if a radio potentiometer or rheostat is available, and many of them should be in these days of factory-made sets. The potentiometer is put in series with a 110-volt lamp, and the flashlight lamp is shunted, or connected across the potentiometer, making connections only at one end of the resistance wire coil, and the contact lever. It is at once obvious that with the lever in the off position, a dead short circuit is placed across the flashlight lamp, and it will not light. Upon moving the contact lever to include some resistance around each lamp, some of the current which flowed through the potentiometer wire now also flows through the flashlight lamp. If the lever is moved too much, the flashlight lamp will be burned out. With a 200-ohm potentiometer, a 50-watt 110-volt lamp and a 12 to 18-volt miniature electric light such as a Christmas tree light, the adjustment (*Continued on page* 339)



Current flows through the tinfoil fuse and lights the lamp; when the current drain is increased by plugging in an electric iron or heater the fuse blows. The experiment is harmless.

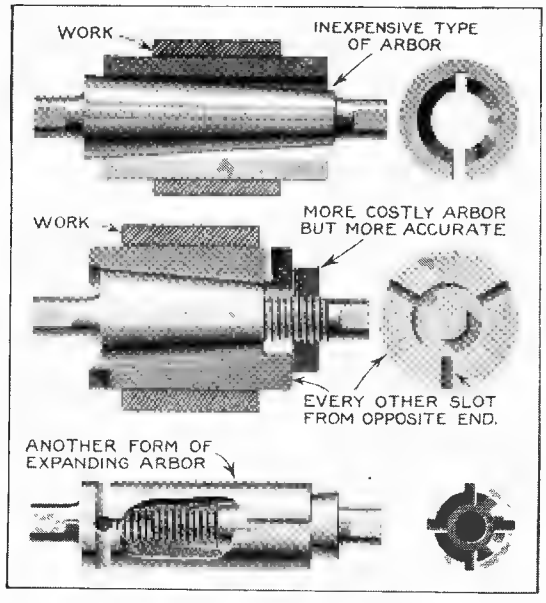


Fig. 1—You will find these arbors invaluable in turning hollow cylindrical work.

For the Home Machinist

Three Types of Expanding Arbors for Holding Lathe Work, Methods of Keeping Pieces in Place to Avoid Errors While Shaping, Means of Maintaining Accuracy in Tapping Stud Bolt Holes, and Various Kinds of Cutters for Boring Jobs Are Considered

By George A. Luers

Supervisor of Ordnance Design, Naval Gun Factory, Washington, D. C.

THE holding of hollow cylindrical work for turning requires some form of arbor. If inaccuracies of .002 to .003 inches in concentricity are allowable, a plain arbor about .01 larger on one end than the other, can be used. If the outer surface and inner bore must be concentric, a more elaborate means to hold the work is required.

In Fig. 1 are shown three of the most usual forms of expanding arbors for holding the work. The making of these arbors is justified where a number of parts of identical size are required. The detail dimensions for each of these arbors is governed entirely by the size of the work. Where only one or two pieces of a part are required, the work should be carefully checked on the face plate of the lathe, tested with an indicator for true running, and bored out as a last operation.

Where a piece of work comes out of a shaper, with faces cut out of square, it is most probable the work moved while machining. In Fig. 2 a usual fault in fastening work is indicated, and means for correcting this condition are shown. If work is chucked and the cutting tool moves it, the faces will be out of square. Where a rod or other piece is used in the chuck jaws, to push the work against the opposite chuck jaw, the job will be held rigid. A "V" block of the type shown is very useful for all around work purposes.

When chucking a job, the solidity is usually determined by striking it with a hammer. When the work is down solid against the chuck, it gives off a dead note. Strips of paper, under edges of the job, will tell quickly when the work shifts, for then the paper will get loose. These thin test slips of paper are easily and quickly placed, and serve as a safeguard, especially on important jobs.

If any drilling and tapping of holes is to be done accurately, a jig of some inexpensive type should be used. It is particularly important, especially where several stud bolts are to be placed. If stud bolt holes are not perpendicular the long stud bolts cant sideways and work will not assemble.

In Fig. 3 is shown a typical example of a jig for drilling and tapping, perpendicular to the face of the work. The "Z" shaped bracket can be improvised from any scrap. Bush the upper end and provide two bushings. One of these bushings is for drilling and the other is for the shank of the tap. The jig is not changed during the drilling or tapping of the work once it has been accurately placed over the center of the hole.

In boring out large diameters, a stout bar must be used to avoid deflection and the resulting run-out of the bore.

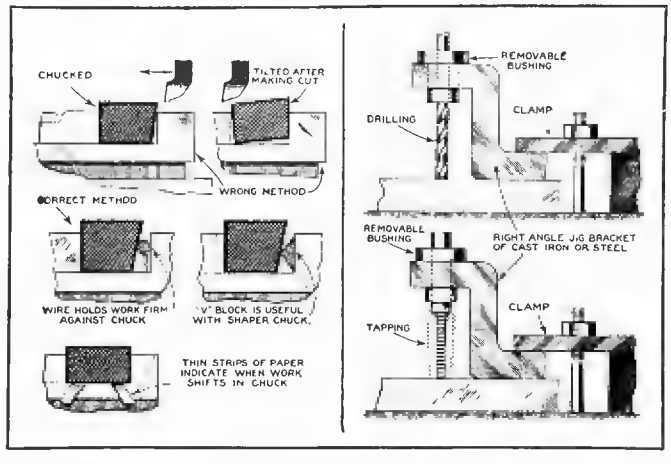


Fig. 2 (left)—How to prevent movement of work while being machined. Fig. 3 (right)—An inexpensive jig will prove helpful in any jigging or tapping of holes.

In Fig. 4 are shown three good ways of mounting tools, to do boring in either the lathe or vertical boring machine. The upper view is of a simple cutter, made from flat stock, and held by a wedge. In the center view is another simple form of cutter, made for inserting through a hole drilled through the bar. The cutter is shaped from drill rod stock. A taper pin locks it in place.

A more elaborate and adjustable boring tool is shown in the lower view. The blades are separate and adjusted by a tapered screw and held by small cap screws. The clamp screws are used to take up side play. These or variations of these forms of cutters will meet most needs for boring out cylinders or equivalent large work. With heavy, rugged boring bars, the work should be supported rigidly.

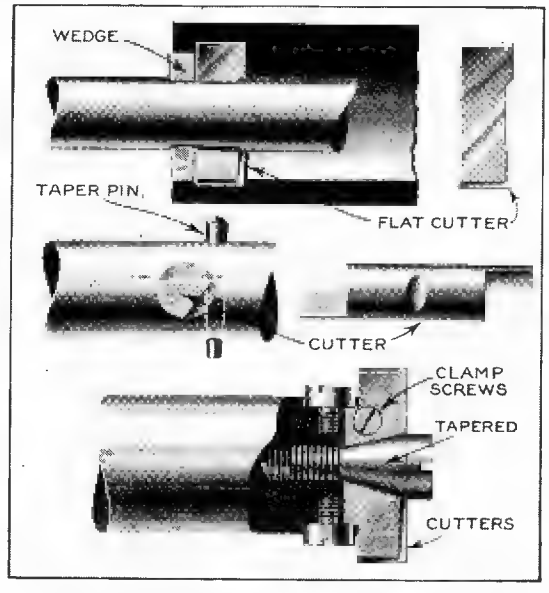
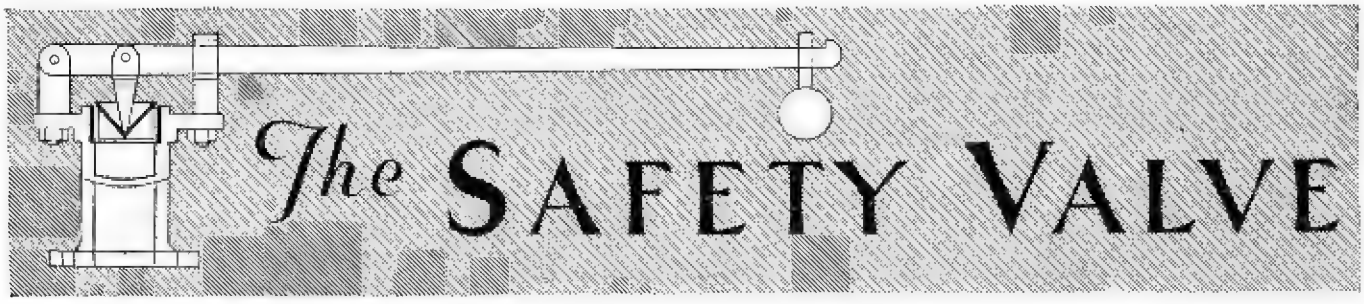


Fig. 4—Be sure that your work is well supported and will not move while heavy cuts are being made.



This Department Is Conducted By and For You. Expressions of Opinion or Comments Are Welcome. Please Address Them to Safety Valve Editor, in Care of this Publication.

Thanks!

THIS is my first and I have been a reader of SCIENCE AND INVENTION since (into) the EXPERIMENTER days. This is really an answer to the mathematics question. I say where would our sciences be if it were not for mathematics? H. Patrie says in SCIENCE AND INVENTION for April, have chemistry and electricity. Where would both these sciences be, if it were not for mathematics, and I also say that mathematics is No. 1 of all sciences.

In closing, I say leave it to our Editor, as SCIENCE AND INVENTION is hard to beat at any stage.

L. E. ARCHAMBAULT,
Cohoes, N. Y.

Harnessing Ocean Temperatures

I'VE been reading your magazine for a number of years—and this issue—January—has an article that has me stumped, up a tree, and guessing.

The article is the one about Harnessing Ocean Temperature.

How can such a contrivance work? How can a scientist with the (supposedly) brains of Dr. Claude, imagine it can work? And last—how in h— did you happen to pass on and publish such an article?

Picking this scheme all to pieces—we'll take it in two sections—the boiler and condenser.

Now it's a cinch that in order to get the water to boil and make steam, a vacuum of several inches will be required. And, according to the natural laws—the more vacuum, the more steam. So he will have to keep the vacuum pretty low in order to run the turbine—even enough to run the vacuum pump.

Now, when the steam rises to 14+ lbs. to the square inch—what has happened? Simply—the vacuum is lost, the water quits boiling, and——

But why go on? Even if the turbine would turn on steam generated under a few inches of vacuum, the vacuum in the condenser would have to be far lower than the vacuum in the boiler. In other words, the suction in the condenser would have to suck the steam out of the boiler through the turbine. Otherwise, the water would quit making steam because the vacuum of the boiler would be killed by the steam already generated. It is impossible to have vacuum and steam pressure in the same boiler.

Now the condenser—and the supply pipe.

We all know that cold water goes down, not up. And the system is used in the heating of buildings.

Even Dr. Claude admits it as he drains the cold water out of the bottom of the condenser. So how in the name of decency can he buck the laws of nature and make that cold water come up through that pipe? If he can do that, why does he not run said pipe up on the hill, or tower, and run a water turbine, instead of a steam turbine that requires outside help to get its vacuum? All he would have to do is let the great ocean pressure shove the water up a few hundred feet above sea level, then turn it loose through a wheel and put Niagara Falls out of business.

No—I've studied that article back and forth, upside down and side-wise, and the only place I can find where Dr. Claude knows what he is talking about is where he says "it takes more power to make it work than what it will generate."

Now, when you decide to publish any more fanciful ideas, why not put a new department in the little old book and head it "Nonsensical Scientists" and then let the Perpetual Motion Nuts get busy and explain their ideas too?

Of course, I may be wrong. But I can't see how cold water will run up hill without help, nor how a vacuum can be made in a tank full of steam and still keep that steam in there.

But just the same, I'll keep on buying SCIENCE AND INVENTION hoping that some one will come along and explain these things.

ED HARPER,
Los Angeles, Calif.

(Your assumption is quite correct as far as it goes but the trouble with it is that it does not go far enough. Did you ever take a flask full of water, bring the water to a boiling point, then seal the flask and invert it, and find upon sponging the bottom surface with cold water that the water would boil again? Steam is given off but if you continue to sponge the bottom of flask with cold water, the water will continue to boil in spite of the fact that the pressure within the flask is being increased because of the development of steam.

The same thing is true with the Claude system. A reduction of the air pressure causes the water in the boiler to give off steam. This steam passes through the turbine which is known as a low pressure type. Coming out of the turbine the steam is rapidly condensed and upon condensation it again produces a vacuum which tends to decrease the pressure in the boiler and allow more steam to form. The operation is substantially the same as sponging the flask as just described.

It is perfectly true that cold water falls and warm water remains at the surface. However, it would be quite impossible for you to sink an open ended tube to a depth of 2,000 feet below the surface and expect that the water would not rise in the tube to the level of the ocean.

We suggest that you glance through manuals of physics and review the text relating to the laws of inter-communicating vessels. Because this water is being brought up from great depths, it is cold. Pumps carry the water through the condenser and discharge the cold water into the open sea. In this way, there is a constant circulation of water and the tube being insulated is always full of cold water.

Unfortunately, in Mr. Claude's original experiments he employed more power to maintain the system in operation than the machine developed. Nevertheless, with careful calculation of the various component parts you should be able to utilize the difference in temperatures to produce power.—EDITOR.)

The Perpetual Pendulum

IN answer to A. C. Tingley about the pendulum in the Peabody Museum, I wish to say that this motion cannot go on indefinitely because of friction. Although it has kept up this motion since it was installed, each consecutive swing is shorter by a tiny fraction of an inch than the preceding one. This pendulum will, within a short time, cease its motion.

Why use up valuable space in your splendid publication by printing problems in algebra and arithmetic? It gives me inconceivable exasperation to turn over a page and find, instead of an article on how to make a model automobile, a long-winded article on how to obtain algebraic formulae for finding out this and that. Your numerous "How to Make It" articles are wonderful, however. Increase the supply of them.

Please do not tamper with your photographs. They are so obviously "touched up" that I think you may as well change the photograph altogether, to suit your particular taste. On page 13 of the May, 1931 issue, are some elephants that look perfectly ghastly, due to your attempts to make them easily seen.

J. L. N.,
Minneapolis, Minn.

(Thanks very much for your criticisms. It so happened that the tone of the photograph to which you allude was of a brownish nature. We did not know that the retouching was going to be as prominent as it ultimately became. We believe that you will find the photographic jobs in SCIENCE AND INVENTION *far better now than they were in the issue to which you allude. Every effort will be made to try to improve the publication, so we are always thankful for any suggestions we might receive.*

There are many mathematically inclined students who would not concur with your opinion of a mathematical feature.—EDITOR.)

Conducted by
Seymour A. Davidson

Airplane Dope

(2395) Mr. Richard Johnson, Boston, Mass., writes:

Q. 1. What is the composition of the airplane "dopes" that are used to cover the fabrics? What purpose does the "dope" serve?

A. 1. The airplane dope that is used nowadays is essentially a collodion solution of cellulose acetate or cellulose nitrate, containing sufficient softeners to produce a smooth, uniform, flexible film, which when dried tautens the fabric, thus increasing its tension. A fabric-covered surface without a protective film would become slack or taut with every increase or decrease of atmospheric moisture. It would also lose its strength rapidly and would give very little protection to the interior wing structures. Doping the fabric-covered surfaces renders them waterproof, tightens the surface to conform to the airfoil section and gives a more nearly rigid wing.

Doped surfaces have from 20% to 25% greater tensile strength and resistance to tearing than the undoped fabrics and the weight of the fabric is increased by about seven-tenths of an ounce per square yard for each coat applied. In addition to strengthening and tightening the surface fabric the dope can be used to act as a protective coating to prevent rapid deterioration from weathering. A clear film of either cellulose acetate or cellulose nitrate dope is transparent to sunlight, and sunlight is the greatest factor in the deterioration of dopes and fabrics through the action of the ultra-violet rays. For this reason pigmented dope is used to cover the initial coats of clear dope. The addition of the opaque pigment prevents the actinic rays from reaching the clear dope and fabric.

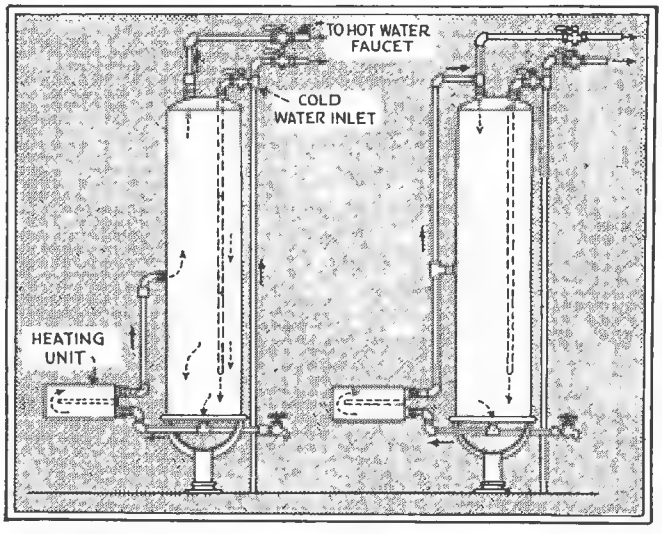
Hot and Cold Water Connections Reversed

(2396) Mr. Thomas Elliott, Alexandria, Virginia, writes:

Q. 1. I am up against a problem right now on a plumbing job and can't find out what the trouble is. I installed a new hot-water tank in my kitchen and connected it to the range. I get plenty of hot water, but the noise is unbearable. Crackling and clicking sounds are heard whenever the water is heated. I consulted two plumbers and they said I had an obstruction in one of the pipes or probably some trouble in the water back. I examined all of these and found them clear. Is it possible that I connected the apparatus incorrectly? I have the hot-water pipe connected to the fitting in the center of the tank and the cold-water pipe connected to the fitting on the left of the center fitting.

A. 1. If we understand your letter correctly, you have reversed the connections to your hot-water tank of the cold-water inlet pipes and the hot-water outlet pipe. That is, the cold-water inlet should enter the tank through the hole in the center of the top. A pipe should lead from this point within the tank to about a foot from the bottom of the tank. The outlet to the heating unit should be taken from as close to the bottom of the tank as is practical. The hot-water inlet from the heater should enter the tank at a point midway between top and bottom. The hot-water outlet to your faucet should be taken from the top of the tank to one side of the cold-water inlet and on the same side to which the inlet from the heater is connected.

An alternative system is also shown in the accompanying diagram.



Left—Recommended plan for hot water system.
Right—Alternative system.

The Oracle is devoted to questions of general interest to our readers. Direct mail answers will be given at the rate of fifty cents per question.

Movie Technique

(2397) Mr. Howard Earle, Haddenfield, N. J., writes:

Q. 1. In the Fox Film, "Just Imagine," which was described in the December, 1930, issue of SCIENCE AND INVENTION, a laboratory scene is shown. Projecting from the laboratory wall are two electrodes or insulators. Rings of light, apparently concentric with the projecting electrodes, are in motion and pass and repass each other within the limits of the electrode lengths. How is this effect produced?

A. 1. The effect of the rings about the electrodes was achieved by double exposure and stop motion camera work. The rings of light of which you speak were polished metal, placed on a black velvet arm and moved a fraction of an inch at a time. They were strongly illuminated while photographed. The film showing these apparent rings of light was superimposed by double printing method on the scene of the laboratory. It must be understood by this that the rings of light (metal rings as described above) were photographed separately from the laboratory scene itself. The superimposing technique explains how they were brought together in the film as shown on the screen.

Regarding the stop motion phase, this is the same technique as is employed to show the gradual opening of a flower on the screen or the movement of inanimate objects such as dishes, cups and spoons by their own apparent volition. After each trifling movement of the metal rings a single frame of film was photographed. When the reel was run off at regular projection speed this slowly photographed motion of the rings appeared to be both rapid and continuous.

Chief Sources of Helium Are in U. S.

(2398) Mr. J. T. Waller, Los Angeles, California, writes:

Q. 1. If it is true that helium can be extracted from metals, river waters, the air and gas wells, how is it that the United States has a monopoly on the supply of this element as is so often stated in the press?

A. 1. The only practical source of helium gas that we know of today is natural gas, of which it is a constituent, that is found in North America, par-

(*Continued on page* 334)

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Should advice be desired by mail, a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

NOTE:—Before mailing your letter to this department, see to it that your name and address are upon the letter and envelope as well. Many letters are returned to us because either the name of the inquirer or his address is incorrectly given.

Page Turner

(1276) A. R. Dozier, Forney, Texas, has submitted a sketch for a music-page-turner that can be adapted to music stands and racks. He requests our opinion.

A. We do not hold that the idea which you have advanced is a material improvement over many other forms of page-turners that have been designed heretofore. One of the simplest construction which we have ever seen operated on the vacuum principle and the page could be turned in either direction. A simple bellows operated by the foot, another smaller one connected to the stand and an air hose were the only requisites. The rod which turned the page gripped it because of the partial vacuum that was produced. The instant this was established, the bellows would fill up and operate the rod to turn the sheet. This page-turner would take any size book.

We do not hold that there is a market for a device as complicated as yours.

Auto Flicker Stop-Lite

(1277) Mr. John Davanzo, Roseto, Pa., requests our opinion of a flicker stop-lite for automobiles.

A. Unfortunately, you have given no information regarding the construction of this stop-lite and it is impossible for us to advise whether you should proceed or whether you should forget the idea. Thermostatic circuit breakers have been developed. If you intend to use one of the many products now on the market and combine it with your stop-lite, we would advise that you would probably have no claim for a fundamental patent. If your system is entirely new, you might find it advantageous to proceed further.

Obtaining a Patent

(1278) Mr. W. S. Cazort, El Dorado, Arkansas, inquires whether SCIENCE AND INVENTION has a department or a service which attends to taking out a patent for an inventor.

A. No. We have not. We take extraordinary care in recommending those patent attorneys whom we know to be competent and reliable. In that respect, we would advise that each and every attorney advertising in the columns of this publication has been found to have given satisfactory service to all of his clients. We have never had a complaint against any of them. We suggest that you communicate with them and secure their literature, their terms and conditions.

Carbon Monoxide Eliminator

(1279) Mr. Valente Burgos, Vigan, Ilocos Sur., P. I., submitted a design for elimination of carbon monoxide by a tank full of water, through which the gases in the exhaust of an engine must pass before they are released.

A. The method you have outlined is very impractical and we do not think that it would at any time be commercially applied.

1. There is the necessity of constantly replacing the water. 2. As the gas bubbles through the water, only portions of the carbon monoxide will be absorbed. 3. There are carbon monoxide eliminators on the market which do not require so much fussing and so much attention and which make the exhaust gas inert. 4. Your method creates a back pressure on the engine which is not found in present-day construction.

We cannot advise further action.

Safety Hand Brake Lever

(1280) Mr. R. F. Hardin, Kansas City, Mo., has applied for a patent on a safety hand brake lever which cannot become accidentally disengaged, to be used for cars or trucks. He requests our opinion.

A. We certainly believe that you will have a worthwhile idea here if you could manage to have it installed on trucks and cars. Unfortunately, we do not agree with you when you state that the item cannot be accidentally disengaged. Should there be any defect of the spring contained within the hand grip, this hand brake would not even engage. It is of course true that the greater the pressure against it, the tighter the brake grip. We think you should be able to make something of use or value out of this system and we certainly wish you the best of luck.

Speed Boat

(1281) Mr. M. S. Chapman, Wheeling, W. Va., has submitted an idea for a speed boat so constructed that the air enters near the bow when the boat is at speed and is forced through pipes to the area beneath the boat upon which the boat rides. He asks our opinion.

A. We feel quite sure that if you will have a patent search made on this item, you will find that you cannot cover the idea as basically as you might offhand assume. Many attempts have been made to do exactly what you are trying to do and in the Spotlight of Science we illustrated two or three of these which have actually been built.

Magic

(*Continued from page* 316)

has now but to carry the trick to a mysterious climax. The mystic writing upon the surface of a mirror has a far more spooky influence than the much overdone slate message production.

The Enchanted Tumbler

THE magician, with a bottle of choice wine in one hand and a drinking glass in the other, advances toward his spectators, and nonchalantly pours some of the liquor into the glass offering a drink to some thirsty member of his audience. The wizard decides to drink with this new made friend, but looking about, suddenly realizes that he hasn't another glass. As drinking from a bottle is not being done by the best people, or at least not after they have passed a tender age, the wizard magically produces another tumbler from space, which he slowly proceeds to fill with liquor, and from which he drinks.

The glass is specially constructed in that it has a thin wire loop attached to its mouth, it was previously concealed inside the bottle. The bottle is really made of metal, and has been enameled, and a label pasted upon it, to give it the appearance of the real modern bootlegger's product. It has a hole to allow the glass to be placed inside it.

The hand holding this bottle slips the wire loop secretly over a finger of the right hand, and by simply transferring the bottle from one hand to the other, the glass is brought forward and apparently magically produced. A bit of misdirection to perform the trick effectively is essential. A compartment in the bottle (as illustrated) holds the liquor.

Candle to Cigar Transformation

A SPECTACULAR trick, performed with articles easily obtained, which will deceive your audience quite as satisfactorily as though high priced paraphernalia and intricate apparatus were employed, is next to be described.

Briefly, the effect consists of transforming a lighted candle into an enormous cigar, by simply placing a cylinder, which has been previously constructed of newspaper, over a candle standing in an unprepared candlestick.

Upon removing this cylinder, it is crushed between the magician's palms, and rolled into a small ball which is tossed aside.

In its place, standing upright in the candle stick, the mysterious cigar has made its magical appearance.

As will be noted by the diagram, the cigar is originally concealed inside of the camouflaged candle, which is constructed of glazed paper, and contains a small genuine candle stub, with wick, for lighting. This candle is carried away secretly covered by the newspaper cylinder, bringing the cigar to view.

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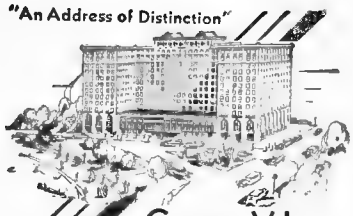

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Among the Inventors

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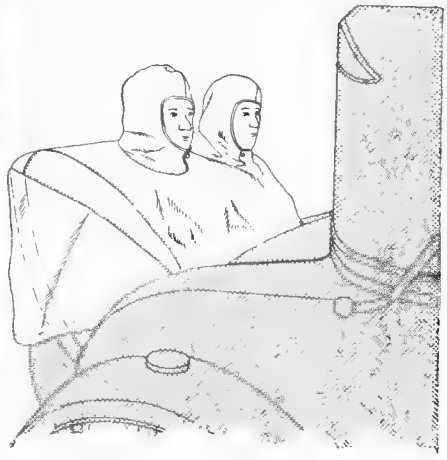
Two Person Rumble Seat Rain Coat

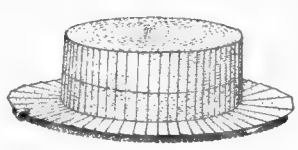
RUMBLE seat riders get plenty of fresh air, but they must also put up with raw winds and chilling rains. When the black clouds gather after a hot, sunny day it doesn't do the "grumble seaters" much good to don slickers and open umbrellas. The thunder shower or persistent rain usually wets the open seats so thoroughly that riding on the soggy cushions becomes a torment.



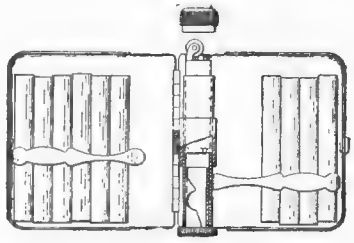
Now that the problem has been presented, here is the solution. When a downpour threatens, simply cover the entire rumble seat and its occupants with a waterproof fabric in which holes are provided for the faces of the two interested parties. Even a cloudburst should leave the rear-seaters high and dry, that is, at least in so far as everything but faces is concerned. Mr. D. W. Davis had the happy thought that finally resulted in this useful article and the patent number is 1,802,807.

A Raincoat for Your Hat

SUMMER showers descend without warning and, no matter how short the duration of the downpour, a straw



hat suffers when exposed to the liquid "element." But why ruin your new headgear when so simple a remedy is at hand? According to Mr. J. Fleischman in patent No. 1,800,933, *all you need do is to cover the woven straw headpiece with one of the newly invented waterproof, glazed paper protectors. The articles may soon be available in numerous sizes and shapes.*



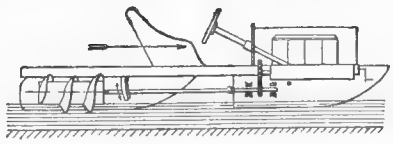
Cigarette Case, Lighter, and Ash Tray in One

THREE-IN-ONE usually suggests a certain well known machine oil to us, but D. S. Beyer through patent number 1,782,026 *has given us the opportunity to extend that phrase to smoking.*

He is not satisfied with the ordinary conventional cigarette case that everybody can have. His device includes a lighter and an ash tray, as a part of the cigarette equipment.

Motor-Driven Sled

WINTER and the accompanying carpet of dazzling snow, which covers the earth, bring fun and—transportation problems. Trains are snowbound, autos skid and dig ruts with their driving wheels from which the cars cannot climb, horses founder belly-



deep in the crystalline formations and man can venture forth only on cumbersome skis or unwieldy snowshoes. That is all past if this invention is generally accepted. We will all be able to make the rounds in winter as well as summer if we take advantage of the sled developed by Mr. F. Wels. The inventor has provided his vehicle with a motor which drives a propelling screw located beneath the sled. The edges of the screw are inclined at an angle of 45°. In motion the screw does not cut into the surface of the snow but merely presses it down so that the sled glides forward and over it. See patent No. 1,790,035.

Oxidation–A Wonderful Tool

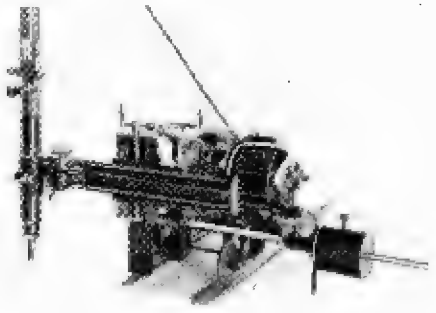
(*Continued from page 291*)

dumped on the scrap pile it somewhat resembles a skull. It was worth reclaiming, but for many years skulls were in the way, too big to be remelted, and of insufficient value to be drilled and cut apart.

Oxidation now does the work in a tricky way. The preheating flame of the oxyacetylene cutting torch is used to make a red hot spot on the skull. Then the instant this flame is removed the end of the quarter-inch pipe is pressed against the hot spot, and pure oxygen is passed through the pipe striking the skull at the hot spot. This starts rapid oxidation of the pipe, which starts to burn and becomes the fuel in place of acetylene. There is not enough iron in the slag skull to continue the necessary burning action without the pipe. Usually five holes, 3 inches in diameter and 12 inches deep are burned into each skull, requiring about five minutes of time for each hole, consuming about 100 cubic feet of oxygen and eight feet of pipe. In these holes are placed sticks of dynamite, which are exploded to blast the skull to pieces small enough to go back into the furnace for remelting.

After the hinged bottom of a furnace is dropped to clean it out, a big sprawly chunk of metal and slag comes from the debris, which also becomes the target for the oxygen lance. The lance may be called on to burn its way through the frozen tap or slag hole of a furnace, plugged up tightly by metal accidentally chilled while flowing to the ladle.

A fine job performed by this humble oxidizing tool in combination with a radiograph is shown. The cutting of the riser of a big steel casting was started by the machine torch, *radiograph*, using 120 lb. oxygen pressure and 15 lb. for acetylene. This machine sent its cut to a depth of about 18 inches. Then one lance of ¼ inch pipe following the radiograph closely sent the cut all the way through the riser. The burning of the steel left a



Courtesy Air Reduction Co.

Radiograph for automatic cutting with oxyacetylene torch.

molten ash and slag, which was prevented from filling up the kerf or cut by the second lance. A job like this consumes about 6200 cubic feet of oxygen, 400 cubic feet of acetylene, and 20 pipe lances ¼ inch by 12 feet long, for each riser.

What could be a more interesting application of the power of the oxygen torch than when it is used far down under the waters of the river or ocean, to cut an opening in the steel hull of a sunken vessel? The diver touches the steel to be cut with a special carbon electrode connected to a source of current (the other supply wire being grounded to the steel of the vessel) and backs it away a short distance to start an arc. This heats a spot red hot on the steel. Then pure oxygen, from the supply boat above, is allowed to flow through a rubber hose and into several small holes in the special carbon electrode so as to strike the hot steel and burn or oxidize its way through.

Acetylene does not work well as a preheating flame for this underwater cutting. The electric arc can maintain a pocket of steam about its flame by the boiling of the sea water, and continue to supply the required preheating flame while the oxygen does the cutting. This underwater torch is much in use by the Merritt-Chapman & Scott Corporation in their wrecking operations, and by others in submarine work.

Quite different from this deep water use of rapid oxidation we find perhaps the most unusual of all—the use of liquid oxygen for blasting. Here oxidation shows its greatest speed and power. In this work a torch is not needed. Cartridges are made of cheese cloth bags, 4½ inches in diameter and 18 inches long, filled with powdered carbon. These are placed in a copper-lined wooden box about 30 inches by 40 inches by 20 inches deep, and liquid oxygen from special containers poured over the carbon cartridges. They are completely soaked with oxygen in a few minutes, which increases their original weight of 3 pounds dry to 12 pounds when soaked with liquid oxygen explosive, LOX. These are taken to the quarry and dropped by string or wire down holes say 6 inches in diameter by 25 feet deep, located from 12 to 20 feet apart. Sometimes 6 cartridges are placed in each hole, and when detonated by an electric spark they will blast about 350 tons of rock per hole. These six cartridges cost considerably less than the amount of dynamite necessary to accomplish the same result. The safety of LOX, as it is called, is one of its chief characteristics, as even a flame would only burn, not explode it when it is not confined. LOX has been transported in can containers as far as 800 miles with but slight loss from evaporation; tests show this loss to be only about 25 per cent after 76 hours exposure to air. But, when LOX cartridges are tamped tightly down in a deep hole of rock or coal the rapid oxidizing nature of the liquid oxygen resists its confinement, which increases the pressure to a point where, when detonated with a spark, its explosive power is about 10 per cent greater than that of dynamite. Here is oxidation working with the speed of lightning, but fully under control. Who will say that man has not made oxidation a wonderful tool?

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Whirlwinds on the Sun

(*Continued from page* 284)

at *a* in Fig. 3, a row of sun-spots were to start exactly in line, after a revolution or two, they would appear as at *b*, the spots near the equator having forged ahead of the others.

Sun-spots show a characteristic structure. All of them possess a dark central region, known as the umbra, surrounded by a lighter area termed the penumbra. The umbral diameter varies all the way from 500 miles, for a small spot, up to about 50,000 miles for the largest. The penumbra may measure two or three times the diameter of the umbra. That a sun-spot is a depression rather than an elevation is shown by its behavior near the edge of the disk, when the penumbral region on the side toward the center of the sun appears much narrower than the region toward the edge.

Sir William Herschel's Sun-Spot Theory

This very discovery led Sir William Herschel to suppose the interior of the sun to be a cold, dark, solid mass, on the outside of which was a fiery hot and luminous cloud layer termed the *photosphere*, the surface that we see. Just below, he conjectured, there must be a stratum of insulation, protecting the cool interior from the blazing outer covering. A sun-spot, then, would be merely a hole in the clouds, through which we discern the dark nucleus. Herschel's ingenious theory, propounded about 140 years ago, held the stage for well over half a century, gradually giving way to other ideas, until the modern conception of spots was evolved, due largely to the researches of George Ellery Hale at Mount Wilson.

The rapidity with which spots develop or disintegrate varies widely, as does their length of life. Most spots are quite ephemeral, lasting but a day or so. Occasionally marked changes are noted within the short space of a few hours. Many spots last for weeks, the "endurance record" being held by one that existed for eighteen months. The average number of spots visible at one time varies greatly in a way that tends to repeat itself about every eleven years, as depicted. Spots never occur near the poles of the sun; they are restricted to two zones on opposite sides of the solar equator, bounded approximately by the fifth and fourteenth parallels of latitude. The complete period, from spot mimimum back to minimum, is known as a solar cycle. The early spots of such a sequence are usually found rather near the fortieth parallels, but as maximum is approached, the entire belt is generally fairly well spotted, while the last trailers of the cycle hug the equatorial section. The causes of this peculiar behavior, or even of the variation, are not known. The closeness of the period to Jupiter's revolution-time about the sun has led to the suggestion that planetary tides may be responsible, but this and similar explanations, like meteoric bombardment, appear to be inadequate and are not generally accepted. The trend of astronomical opinion appears to be toward the belief that sun-spots are the result of internal rather than of external disturbances.

In one sense, the term *solar atmosphere* is a misnomer since the sun is gaseous throughout. The outer fringe of the sun is partially transparent and it is this layer of gas that is usually spoken of as "the atmosphere." There is, however, no sharp division between this and lower levels, as in the case of the earth. We can see only the topmost parts of the storm-stricken regions; in all probability the violent upheavals originate far below the visible surface.

A terrestrial tornado is likely to occur when the barometer falls to an unusually low mark. Air will, of course, tend to flow toward a low-pressure area and, in so doing, acquire rotational velocity (cyclonic motion) as well as a lowered temperature. Sun-spots are whirlwinds produced in quite an analogous manner. The curved filaments at the edges indicate the rotation; the hol-

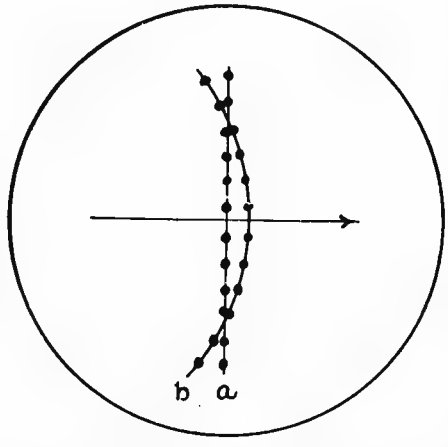


Fig. 3—If sun spots were lined up as at a, they would appear as shown at b, after the sun had completed a few revolutions.

lowness of the spots shows that we are looking down into the top of the "tornado funnel"; the blackness of the region attests the lowness of the temperature, for the cooler gases do not radiate as much light and heat as the neighboring hotter regions. It is obvious that so great a difference of temperature as exists between spot and photosphere cannot arise by itself.

Furthermore, the forces that cause a spot must continue to operate throughout its life; otherwise, the unequal temperatures would rapidly be evened. The rapid whirl of the spot acts like a centrifugal force-pump, the gases being sucked upward from the hot interior and cooled by expansion, a natural process that is reproduced mechanically by the popular "iceless" refrigerators of today. The giant hailstones that frequently accompany terrestrial tornadoes are frozen by an action of this sort. It is interesting to note that a sun-spot is by far the most powerful refrigerating device known to science, for here we have a continuously maintained difference of some 2000° in temperature between spot and surface. One must not jump to the conclusion that sun-spots are truly *black*: They appear so only by contrast with the much brighter background. If it were possible to blast the sun into sudden obscurity, leaving, as a fragment, a single large spot, do not imagine that the earth would be plunged into darkness, for the light ordinarily emitted by the "black" spot would illuminate the earth with a brilliance surpassing that of the full moon by more than a hundred fold.

Everyone knows that electricity, flowing in a coil of wire, will generate a magnetic field. The matter composing sun-spots is made up of atoms, fragments of atoms, and electrons (negative electricity), for the collisions between the atoms tend to smash them to bits.

Do Sun-Spots Affect the Earth?

Zeeman discovered that light emitted in a magnetic field has decided peculiarities. For example, we know that one of the yellow "D" lines of sodium is split by magnetic force into six while the other line is separated into four components. Hale employing powerful instruments searched for such an effect in sun-spots and concluded, since he found their spectral lines divided in the manner above described, that the tornadoes are truly enormous magnets.

Sun-spots do affect the earth. We have known for years that the appearance of a large spot group is often marked by terrestrial magnetic disturbances, e. g., interruption of telephonic and telegraphic communication and the occurrence of brilliant auroras*. Furthermore, the researches of Abbot and his co-workers indicate that the sun gives off a slightly greater amount of heat during the part of the solar cycle when the spots are most numerous. In spite of this, the temperature of air near the earth's surface appears to be cooler than the average at sun-spot maximum, probably a secondary effect arising from altered atmospheric transparency. It has been suggested that rainfall, also, is *partially* dependent upon the prevalence or absence of spots, and, though the evidence for this is not entirely conclusive, it is not unlikely that such a relation exists. But the pseudo-scientists who claim that they can predict next week's or even tomorrow's weather from the configuration of sun-spots, are either charlatans or grossly self-deceived. It is true that knowledge of the nature of sun-spots and of their relation to terrestrial phenomena is in its infancy, but science has progressed far enough to determine definitely that spots have no more than a secondary influence upon the weather.

*The nature of auroras will be fully discussed in the next article of this series.

Can Science Measure Luck?

(Continued from page 302)

ions play an important part in certain aspects of atmospheric electricity. Similar remarks may be made about most of the phenomena which are vital to modern physics."

Sir Ernest Rutherford has said that the number of molecules in a cubic centimeter of air is so vast that if every human being on the surface of the earth began counting them at the rate of three a second each, it would take 300 years to finish the job. Yet using the laws of probability we have been able to count the number of molecules in a cubic centimeter with greater accuracy than it is possible to count the number of individuals living in New York City.

Business—Organized Scientific Gambling

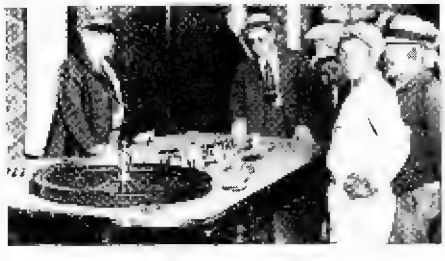
Not alone in science but in every field of business do we use this science of gambling. Suppose, having a thousand dollars, I decide to start a life insurance company. I insure you for a thousand dollars and tomorrow you are killed by a taxicab. My insurance company is at an end and I have lost all but your first premium of my original capital. That was not good business. But suppose I have $100,000 and I insure a hundred people in different localities and in different occupations for a thousand dollars each. Surely not many of them will die at once, and if I charge a proper premium the chances are that I will have collected enough money to pay off any claims as they may come due. But still there would be a good chance of my company going on the rocks. But if I insure ten thousand or a hundred thousand persons, then my company has removed all the chance from the venture. It has now become a business and if I have based my premium on the age, occupation, condition of health, and so on, of my clients, and have added an amount which the laws of probability tell me should yield me a fair return on the capital invested in the business, then I may be sure that I will actually realize the predicted return within close limits; the closeness improving with the extent of the business.

In the same manner railroads determine the number of cars necessary on any given train on any particular day. The telephone company estimates the number of calls probable at any particular hour and has a sufficient number of operators present to handle them. All these things can be determined beforehand on the basis of past statistics.

As precision increases our laws of probability give us more and more valuable information. This has been very well illustrated by Dr. Wilmer Souder of the Bureau of Standards. "We are so accustomed to the usual methods of description, which are only approximate, and by virtue of these approximations are susceptible to no precise interpretations, that we fail to recognize the extreme accuracy of identifications made by precision measurements," he says. "When we are looking for a man six feet tall of rather heavy build, with dark hair, with a scar on one hand and with some gold teeth in his mouth, we should not be surprised to find several hundred citizens of the United States who meet the description. If we increase the precision of the description to a man of seventy-two and a half inches tall, weighing 207 pounds, index finger of left hand amputated at the second joint, and with gold crowns on right and left bicuspids, we may feel sure that there is not more than one man in the entire country who will meet the specifications, and, having found this one, further search cannot be justified without the introduction of unusual condition."

Defeating the laws of chance by methods which yield great precision is often very costly but on the other hand has often ultimately proven cheap in the long run. The struggle has led to our methods of quantity production. If we were to supply a hundred men with copies of the same blue print showing a plate with a dozen holes around the edge and asked each to make one we would find no two alike, even though the men were skilled machinists. No two plates would be interchangeable if held to close working tolerance. The laws of chance would have entered to make them all slightly different. Yet it is possible today to make a hundred automobiles, dissemble them, pile all the parts in a heap, and reassemble from the pile a hundred cars from any suitable parts picked up at random. We have eliminated the laws of chance by using either a plate, with holes spaced properly, and drilling new plates only through these holes, or perhaps by using a gang drill, a device in which all the holes are drilled at once by bits held in the proper positions in chucks. Discouraging enough in the beginning, and costly too, the laws of chance have forced us to use this great labor saving scheme.

And so one could go through almost every activity and find therein some gamble. We gamble our lives that we can cross the street without getting hit, we gamble our fortune that our business will not be rendered obsolete by some new invention, we gamble pleasures which we might otherwise enjoy against our living to an old age and needing the money, we gamble our eyesight that a glass of bootleg liquor is free from wood alcohol, even though we know nothing of its source. We are essentially gamblers and, while a wave of moral reform may occasionally cause us to forego a few forms of gambling, you may rest assured that eventually we shall come back to it again. There are few things more fundamental to our natures.



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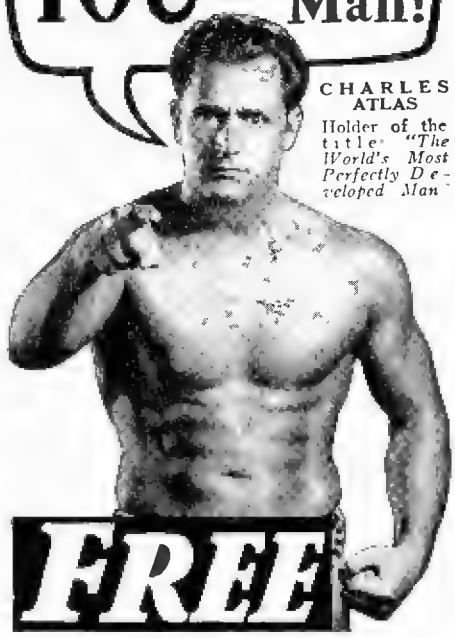

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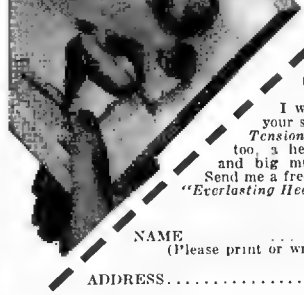

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An Idea That Grew into an Industry

(*Continued from page 289*)

the boiler and the start towards a piece of soft ground, of which there were so many thousands of acres close to Stockton.

Floppety-flop went the loose treadmill "wheels" as they picked up the long spans of link belting and laid them down again. But it was a principle—not a mechanically perfect machine that Benjamin Holt was proving that day.

And it worked! It laid its broad tracks right over the soft peat lands, bearing up the enormous weight of the huge traction engine. Here at last was practical, light-weight distribution of heavy weight—lighter pressure per square inch, it was subsequently proved, than the weight per square inch of the average man. And here was sure traction, for each cleat did its bit. Success, wonderful success. A new machine, fittingly named the "Caterpillar," had made its bow to the world.

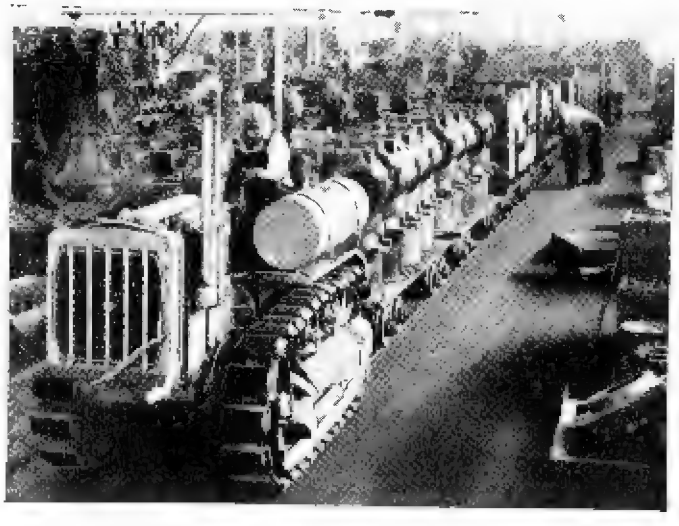
But there was one more factor the manufacturers were desirous to know about. How good a puller would the Caterpillar prove to be?

A second machine, powered by a 40-horsepower engine, was therefore built to work especially on the endless tread or track-type principle—which machine was the first true all-Caterpillar. Its performance was tested in comparison with that of a 60-horsepower round wheeler. The latter machine, with 20 horsepower to the good, was loaded to capacity with a 15-bottom plow, but the smaller track-type machine pulled a 20-bottom plow two inches deeper and with ease. The next year the first commercially built Caterpillar was sold to a development company for use in the marsh lands of Louisiana—truly a most suitable place to test its worth.

But the year 1908 saw the Caterpillar go "over the top." Work was being started on the Owens Lake Dam and aqueduct across the Mojave Desert for the Los Angeles water supply. Power problems were manifold. Thousands of tons of material had to be hauled over soft, burning sands and trackless wastes, over mountains and through roadless ravines. Even mules were out of the question, for there was no food or water to sustain them.

But some one had heard of the Caterpillar. In desperation the engineers wired the Holt company to ship them a machine. In a few weeks an order came for two more and early the next year for twenty-five gasoline-powered Caterpillars—for the company had in the meantime changed from steam to gasoline power plants. This order taxed the production facilities of the Holt factory for five months. But the machines went to the job and earned world-wide recognition for their performance in helping to build the Los Angeles aqueduct.

This story about the background and development of an idea would scarcely be complete unless it told of some of the uses to which the new-found principle has been put—uses which the inventor, although a far-seeing man, could hardly have foreseen. He could scarcely have visualized his creation in the rôle of a monstrous war machine — creeping fortresses capable of fording streams and ditches, crossing railroad tracks and barbed-wire fences just as if they hadn't been there; crawling right on top of machine-gun nests and other concrete fortifications—"pill boxes" they were called—and crushing them as easily as they would crush cases of eggs. "Tanks," the British named them, but that name hardly conveys their significant meaning. To the men who fought in the World War they were land battleships.



Caterpillar Thirty with rubber tracks used as a switch engine on plant narrow gauge railroad.

Thousands of Caterpillars were made for war service, both as armored tanks and for transportation purposes. The Germans employed them first and the Allies could hardly imagine what kind of machine it was that was moving supplies up to the firing lines. Certainly railroad tracks would be blown up as soon as they were laid.

But the peace-time uses of the Caterpillar offer more varied and interesting insights into the phenomenal growth and employment of this tractive idea.

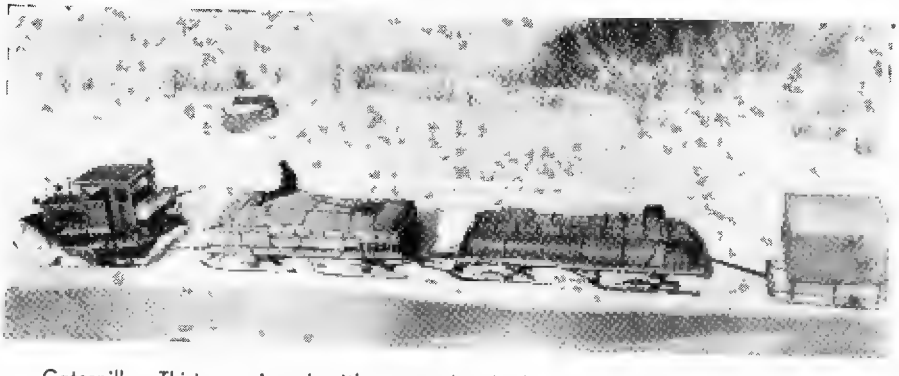
The reader perhaps lives in the snow belt—thirty-six out of the forty-eight states, with their 100,000,000 inhabitants are subject to snowstorms that might easily, and oftentimes do, cripple transportation. Take, for instance, the town of Colesburg, Iowa, a community of 350 souls, which became isolated for several days, all the roads leading to the town being blocked with drifts from eight to ten feet deep. Its fuel and food supplies were running out. Desperation seized the people.

Now snow and ice, as everyone knows, are slippery substances, and any kind of traction must be able to grip before it can do much work. With the Caterpillar, the endless treads and cleats provide that grip. A huge snow plow, pushed by one of these tractors, cleared the fourteen miles of road in one day and liberated the people from danger.

And in Alaska, when the winter season sets in and even the railroad through the White Pass and Yukon territories becomes hopelessly blocked, the lay-their-own-track tractors haul tons of necessities on sleds to the inland trading posts.

The lumbering industry has adopted these tractors, too, for great quantities of material, besides lumber and logs, are required in operations. The sure grip and the steel cable, operated through winches and niggerheads, have combined to handle otherwise inaccessible logs.

In all parts of the country, and of the world, good roads have been every man's gospel. The creation of new roads through forests, through fields and jungles seemingly awaited the coming of the Caterpillar, for it alone has proved capable of embarking upon such enterprises. Stump-pulling machinery, plows, scrapers, ditch diggers, dirt load-



Caterpillar Thirty equipped with snow plough, hauling supplies for the Canada Power and Paper Co.

ers, the erection of power line towers and poles, the baling of alfalfa and hay—these are but a few of the industries that have put the "tractor that will go anywhere" to work.

In Florida we find it engaged in cultivating the swampy lands of the Everglades, its light-bearing tractive qualities enabling it to survive wiggling over the bogs. In the desert countries it is used to clear sagebrush. Two of these mechanical crawlers will start across a field parallel to one another about a hundred feet apart. Between them will be several lengths of railroad track and heavy chain. No wild brush can stand this onslaught, and thousands of acres have been cleared in this way. Afterwards the tractors pull ditch-diggers for irrigation purposes, plow the land and make it ready for cotton.

At airports? Yes, the construction of airports is largely a mammoth dirt-moving and grading job, and how many airports could have been constructed, at least economically, without them? Truly, Benjamin Holt could hardly have foreseen his tractors moving large airplanes in and out of hangars.

Today the several companies engaged in the manufacture of track-type tractors represent plant capital running into the hundreds of millions of dollars. The tractors are to be found in every nook and corner of the world—from the Arctic Circle to the jungles at the Equator, adding untold wealth to the treasures of the world. Born of Mother Necessity to meet a situation peculiar to the delta lands of California, the tractor has crept and spread its influence far beyond anything ever dreamed of by the inventor who simply had to solve a difficult tractive problem.

How to Preserve Butterflies and Moths

(*Continued from page* 311)

the soft pine wood. Carefully pull out each wing by placing a pin directly below the heavy muscle at the base of the wing and secure it in a natural position with the pin forced into the board. A good rule to follow in pinning out a butterfly or a moth is to raise the primary wings toward the head of the specimen until they are approximately in line with each other along the upper edge. The wings of the specimen can be protected and dried in the proper position by covering them with squares of glass. Place suitable weights on the cover glasses in order to force the wings and body into the proper mounting position. Keep the specimen in this position in a warm dry place for two or three days. If the body is extra large, it should be allowed to dry for a longer period of time.

The wings of the specimen should always be relaxed before attempting to pin out on the drying board. To relax place the dry specimens on damp sand and cover with a jar. Keep under the jar until wings will properly relax. If the specimens are collected and pinned out the same day, the relaxing process is usually not necessary.

The mounting cases are made from plaster of Paris, which can be purchased in the powdered form at almost any general store. Two pounds will supply material for the first attempt. Secure a number of small shallow pasteboard boxes or box lids having a depth of approximately three quarters of an inch and the other dimensions suitable for making one or more cases.

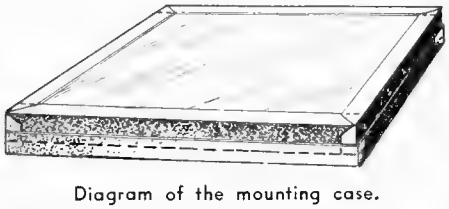


Diagram of the mounting case.

Now cut rectangular pieces of window glass to fit snugly into each box. Carefully wash the prepared pieces of glass before laying them in the boxes. Mix the plaster of Paris in a porcelain pan or any suitable container. Add cold water to the powder and stir well. The mixture should be thin enough to pour from the container.

The boxes should be arranged near by and as soon as the plaster of Paris is prepared fill each box and level down with a piece of glass. This work should be done rather rapidly as the plaster of Paris begins to "set" in a short time. Allow the casts to stand until they are perfectly dry, then remove the pasteboard and pry off the glass by carefully inserting a penknife blade under one corner of the glass. The smooth side of the cast and the loosened glass will form the top of the mount.

Select a dry specimen to be mounted and a cast of suitable size. The casts may be cut into smaller sizes by sawing. The cover glasses are also cut to the proper size. An inexpensive glass cutter will serve very well for the purpose. A little practice with a glass cutter will render one sufficiently adept in the art of glass cutting and incidentally the experience may prove valuable in general household repair work.

Place a lead pencil mark on the cast to indicate the approximate position for the body of the specimen and with the half-round gouge cut out the cast to form a receptacle for the body of the specimen. Use fine sandpaper to finish the body receptacle. Place the specimen on the cast and cover with the glass. Bind the glass in place with black cloth binding tape. The cloth tape can be purchased by the roll at a bookstore. The diagrams will show the method of cutting the binding tape before pasting it around the cast. Paste a blank piece of paper on the back of the cast and record pertinent remarks.

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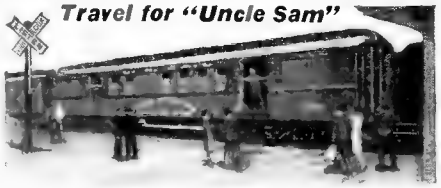

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Phenomenal Developments in Micro-Photography

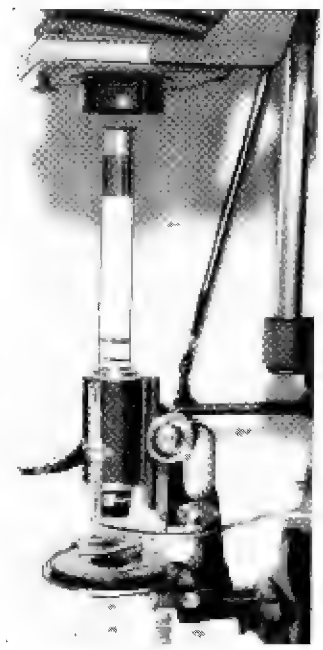
(Continued from page 292)

eliminate the heat thus generated (which would instantly burn up the specimen) it was necessary to pass the rays through a water-cell. This consists of a half-inch petri-dish fastened to a sheet of glass with ceiling-wax, with a portion chipped out of the top for filling purposes.

The sliding track for the mirror is merely a brass rod, bent to shape, double at the top to prevent rotation, and having a base for fastening it to the camera bed or table, as shown in one of the accompanying illustrations.

Microscopes are only made to take the regular objectives and the small Micro-Tessar lenses, but by taking off the front and fashioning an appropriate lens ring, a 72 mm. Micro-Tessar can be used satisfactorily, although the barrel of the scope cannot be racked back sufficiently to get the object in focus. This difficulty can be eliminated by removing the substage condenser and placing the specimen at the rear of the opening.

This will give magnifications up to 12 diameters, and by making a tube as shown in an illustration to take the No. 4 eye-piece, accurate photographs of specimens such as plant-lice, grain weevils, lichens, etc., can be taken as high as 60 diameters. The exposures normally require about as many seconds as the number of times of magnification, i.e., thirty diameters requiring 30 seconds; although if the specimen is whitish in color, reflecting a considerable amount of light, the exposure may be reduced to one-third that amount.



Tube for coupling 72 mm Micro Tessar with eye-piece

Focusing should be done with the lens stopped down to about F. 16, as the increased depth of definition thus secured is the same above as below the point of actual focus. In doing this use a hand-mirror in one hand to view the image on the ground glass, while manipulating the microscope with the other.

With the 32 and 48 mm. Micro-Tessar lenses the magnification can be carried up to considerably over 100 diameters, and for microscopic or extremely flat subjects, such as portions of insect anatomy, plant spores, etc., wonderful photographs can be taken as high as 200 diameters by using the 16 mm. microscope objective and a 10 eyepiece. For such magnification, however, only the most delicate surfaces, requiring a minimum in the matter of depth of focus, should be attempted. The microscopic objectives being necessarily used "wide-open," are extremely fast, and the exposures at 200 diameters require but a very few seconds.

Panchromatic plates give the best results, and there is so much yellow in the arc itself that little or no extra exposure is required when using the correct color screens.

White backgrounds are secured by placing the specimen on white paper; gray grounds by placing the specimen on clear glass with a piece of dark, semi-transparent kodak film back of the glass; and black backgrounds by using clear glass without any background.

In view of the multitude of combinations that can be had with lenses, eye-pieces, and bellows-draw, it is imperative that accurate tabulation be kept of each successful experiment. This will eliminate all necessity for experimentation in future work of a similar character.

Note: The writer will be glad to be of any assistance possible to colleges and medical institutes whose research in embryology, etc., might be furthered by the use of the process herein described.

The Oracle

(Continued from page 324)

ticularly within the boundaries of the United States. It is true that helium has been found in very small quantities in several natural gas wells in Europe, but in each case in such small proportions that commercial extraction is impracticable because of cost. The existence of helium in natural gas has been reported in South America, but data are lacking as to the quantities available. In Canada helium is found in workable amounts, but by far the greatest content combined with extensive fields occurs in the mid-west part of our country.

New Sun Motors to Produce Terrific Temperatures

(*Continued from page 299*)

special kinds of electric furnaces chiefly developed by Dr. E. F. Northrup, in which the heat is generated electrically inside the substance to be heated. But even these furnaces are not usually applicable to the heating of substances which do not conduct electricity, nor has it been possible to attain in this way temperatures even approximately as great as those of the surface of the sun.

The experiments now in progress in California contemplate the production of a multiple, highly efficient burning glass. A number of separate lenses, each as transparent as possible to the rays of heat and light from the sun, are so mounted and arranged that the radiation focused by each lens comes to a general focus at the same point. Theoretically, there is no limit to the temperature which can thus be produced at the point of general focus, provided that a sufficient number of large lenses can be used, and provided also that there is present at the focus some substance, like black carbon, which will absorb the concentrated rays.

Probably there would be a limit at about the temperature of the sun itself, for at this point the heated material at the focus of the lenses would begin to radiate heat almost as rapidly as the heat was supplied. Even this limit is scarcely likely to be attained practically, since a droplet of fused carbon at the temperature of the sun's surface not only would burn its way through any known material in which it could be placed, but would itself be turned instantly into carbon gas.

As long ago as 1860, M. August Mouchot, with the assistance of the French Government, began extensive investigations of the use of solar power, the idea being that such power might be used to pump water for irrigation in the arid provinces of France and the northern edge of Africa. Apparatus based on M. Mouchot's designs was installed at the Paris Exposition in 1882 and used to run a small engine which drove, in turn, a printing press on which the world's only example of a sun-power newspaper was printed day after day.

Between 1900 and 1905, in Arizona and California, an American experimenter, Mr. A. G. Enear, constructed several solar engines consisting of numerous mirrors mounted on a frame and so set as to concentrate the solar heat upon a small steam boiler located at the center of the contrivance. These engines worked quite successfully and were able to produce steam power or electric power at practicable costs. A few years later, in Egypt, other solar engines, based on designs of the American experimenter Mr. F. Shuman and the British physicist, Dr. C. V. Boys, also attained a measure of success in pumping water for irrigation.

Never has there been available, however, a very high degree of heat at the boilers of these solar engines. Very high temperatures and similarly high steam pressures are found by power engineers to yield greater efficiencies and lower power costs than can be attained with low temperatures and low pressures. That is why engineers as well as scientific men look with interest to the behavior of solar devices producing much higher temperatures like those which it may be possible to obtain as a result of experience with the small high-temperature apparatus under construction at Pasadena.

The total quantity of solar power available is known to be enormous. On the basis of measurements of the so-called "solar constant," which is the amount of solar energy reaching a unit area of the earth's surface in unit time, Professor Henry Norris Russell of Princeton University computes the total solar power per square mile of sunlit earth's surface as approximately 4,690,000 horsepower. With reasonable allowances for varied exposure of different portions of the earth, this amounts to something like two hundred thousand billion horsepower as the total amount of solar energy which the earth receives.

Much of this enormous power already runs man's machinery and is otherwise useful, for this is the energy that keeps the winds in motion, that evaporates ocean water to produce the rains and the water power, that is absorbed by plants to produce wood or oil or alcohol or other fuels, and which goes otherwise to keep moving virtually everything that moves on earth. Even our coal and oil represent similar sunlight which has been captured by plants in past geologic ages. Of all of the sources of power on earth only a very few tiny ones like the power occasionally taken from the tides, or from the internal heat of the earth, come from any other source than past or present sunlight.

In spite of this, all but an infinitesimal fraction of the sun's energy striking the earth goes continually to waste. The engineering difficulty in utilizing it is that the solar energy is so diffuse. Lenses, mirrors, or other devices to catch it, necessarily must cover acres of ground or even square miles. Such constructions are expensive. That is why it is cheaper to use what might be called "fossil sunlight" in the form of coal or oil which can be mined and handled in concentrated form.

This picture may change, however, if the Pasadena scientists or others succeed in making apparatus by means of which much higher temperatures can be produced in a practicable manner. These researches are justified, furthermore, by the physicist's need for these high temperatures themselves, so that any facts which are learned about the practicability of new sun motors will be an inexpensive byproduct of the research.

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Raising Toy Fish for Profit

(*Continued from page* 295)

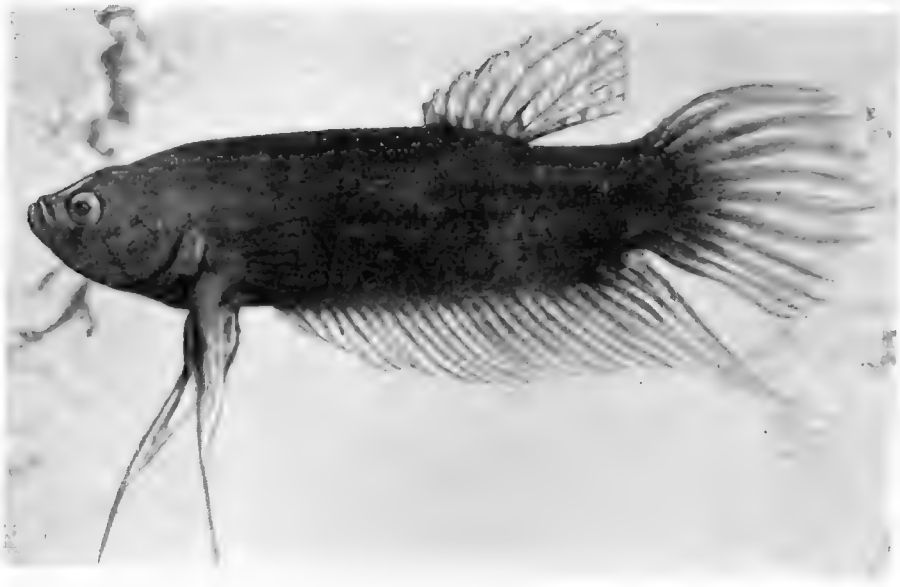
from the pail into the tank by directing the stream of water on the paper. If desired, a slow stream of water may be poured on the paper with a watering can or other vessel.

Place the tank in a well lighted but not too sunny location, and after the lapse of about ten days to two weeks, the plants will show signs of growing. When this occurs, fish may be placed in the tank, which has now become a balanced aquarium. In such a balanced aquarium it is absolutely unnecessary to change the water; in fact the water in the tank is never changed, it remains for years and only that part which has evaporated is replaced.

The submerged water plants play a very important part in the aquarium. It is their duty to take up the carbon dioxide exhaled by aquatic animals, the fish, and give off to the water the necessary oxygen so that the fish may breathe. The life process of the plant permits this exchange of gases. The plants require the carbon dioxide in the formation of their tissues and during the manufacture of the tissue material, oxygen is given off as a by-product. It is for this reason that the aquarium should be plentifully supplied with aquatic plants.

The keeping of fish in a balanced aquarium during the summer months requires little care or attention. Even the delicate and showy tropical forms are unassuming in their demands. But when the colder season of the year comes around, then the tropical fish require extra attention. Precautions must then be taken to see that the water in the tank does not become too cold. This can be accomplished in various ways. The simplest method consists in covering the entire aquarium with a box of cardboard during the night. This keeps the water warm. Or the aquarium may be heated by an ordinary electric light bulb, care being taken that no water actually touches the bulb. Electric heaters can be used, special aquariums can be obtained, or even made, which can be heated by a small alcohol or kerosene lamp.

Keeping fish is easy; breeding them requires a little more knowledge, especially a knowledge of the characteristics of the individual type of fish being bred. Some fish build nests; others do not. *Betta splendens,* the Siamese Fighting Fish, a native of India, builds a nest out of air bubbles. It is the male that constructs the nest and it floats on the surface of the water. But in order to breed, the water should have a temperature or 25 c. (77 F.).



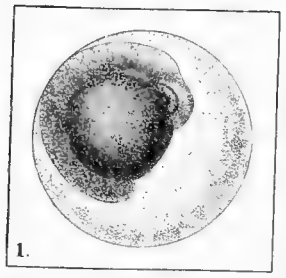
Betta Splendens, Siamese Fighting Fish.

After the eggs have been fertilized, the male picks them up and deposits them in the nest of foam, where they remain for about 24 hours, before they hatch. When the fry has hatched from the egg, it sinks back into the water and is taken care of by the male for about five days. After the female has spawned her eggs, she should be removed from the aquarium and placed in a separate container so that she can not attack her own young. The fry should be placed in a separate tank with shallow water for the first few weeks of their life.

During the breeding season of the Indian fighting fish, no two males should be in the same tank. This toy fish is a fighter and two males will fight to the death. This fact is known to the Siamese and they arrange fish combats for sport. It is especially during such a fight that the fish assumes its glowing metallic colors of indescribable splendor.

Another fish that builds a nest of foam and which is a native of India is *Colisa* (*Trichogaster*) *lalia.* It is quite abundant in the Ganges. The male has a deep blue breast and a body having 12 or 13 lateral red stripes. The threads on the ventral fin are red. The rear end of the dorsal fin is pointed. The female is provided with 10 red stripes, the ventral side is whitish, while the threads on the ventral fins are yellow and the rear of the dorsal fin is rounded. For breeding these fish, the water should have a temperature of about 30 c. (86 F.); at other times the temperature may sink to 20 c. (68 F.). The male builds the nest of air bubbles and includes in it minute parts of plants, etc., which are all united into a rather firm whole. Spawning takes place under the nest, the eggs rising up into the nest of their own accord. After spawning the female should be removed from the spawning tank. The male protects the eggs, which hatch within 24 hours. The depth of water in the spawning tank should only be from 5 to 6 inches. When the fry hatches, the male should also be removed. For a few days the young feed on algae and infusoria which are always found in a long established aquarium.

In China is found



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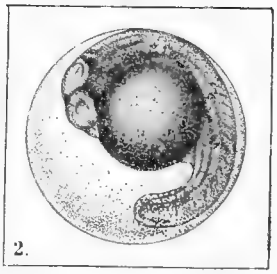


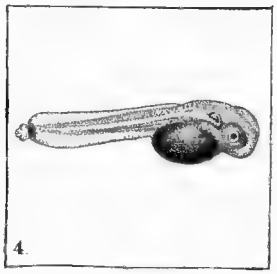
2.

1—The egg of the Indian fighting fish six hours after spawning. The fish itself is almost formless.

3.

3—18 hours later the tail end of the fish has emerged from the egg. All drawings in this group are highly magnified.

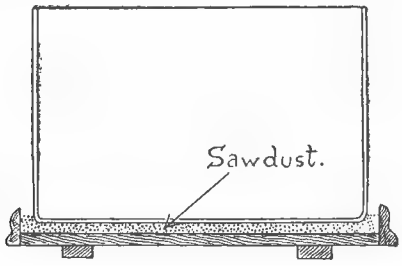
2—Twelve hours after spawning the fishlike body makes its appearance within the egg.



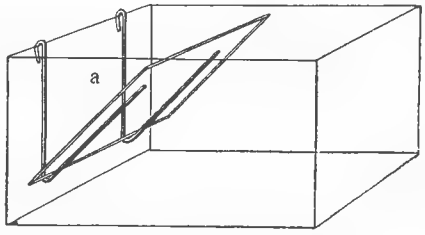
4.

4—When the fry is about to hatch from the egg it looks like this. The fish is now 32 hours old.

Macropodus opercularis, another nest builder who prefers an overhanging leaf of an aquatic plant under which to construct his nest of minute air bubbles covered with saliva. This fish is quite hardy and may be kept, even in winter, in a well heated room. The male is of brighter coloring than the female. This is one of the first toy fishes to be introduced and kept in aquariums. During the breeding season the male builds the nest, the spawning takes place under the nest and the eggs rise into it. Any that refuse to rise are taken by the male and



A full glass aquarium placed in a small shallow wooden box filled with saw dust. Mounted in this way the full glass aquarium is kept from premature breakage.



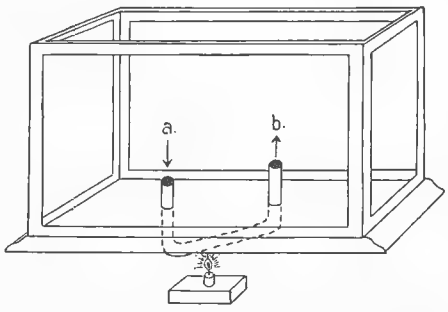
Spawning box made of two wires and a sheet of glass. The female is placed in compartment a; the fry falls out of the box through a slit at the bottom of the glass.

deposited in the nest. After spawning, the female should be removed. The eggs, which are repeatedly covered with fresh bubbles, develop for about 36 hours, after which time the young fry appear. The male watches over them carefully for about 5 to 8 days, but when he can no longer keep them together the male loses interest and may devour his own young if not removed at this time.

One of the most popular of toy fish is the so-called leaf fish, *Ptcrophyllum scalare*, a native of the Amazon river in Brazil. Dorsal, anal and ventral fins are peculiarly lengthened and partially covered with scales. The body is flat, silvery in color and provided with dark bands. The fish are sluggish, poor swimmers and usually remain motionless in one position for hours at a time. The temperature of the water should be 25 C. (77 F.). At the time of spawning, a space is cleared about some water plants and the eggs attached to them. Soon after the spawning and fertilizing of the eggs, the parent fish should be separated from the spawn, the latter being placed in a shallow tank which should be aerated. Within two or three days the fry hatches and wiggles around the bottom of the tank. At the end of about five days the fry begins to swim.

If one has a good pair of leaf fish then it is not necessary to remove the spawn. The parents will hang up the just-hatched fry from various submerged plants where they remain suspended for about four days. The parental care of the young is now at an end and the parent fish must be removed from the fry if the latter is not to be devoured.

Another popular type of toy fish is the life-bearing tooth carp, many forms of which may be easily obtained and all of which are easy to keep and to breed. The male is much smaller than the female, while both are comparatively tiny. They are native to our own southern waters. Many come from Central America and the West Indian Islands. In this particular type of fish the eggs are fertilized within the body and the eggs develop within the ovary. After one fertilization various births are given, even though weeks and months may intervene. The period of gestation may last from four to five weeks if the water is normally warm. If cold, a longer time is necessary. The number of fish born at one time varies considerably. The parents are generally cannibalistic in the aquarium, although seldom so in nature. It is therefore wise to remove the fry as soon as possible or else the use of a densely planted aquarium becomes a necessity. In such a tank the fry can hide from their parents. Conscientious aquarists place the female in a spawning box, a small container hanging in the equarium. This has small slits in the bottom which are just large enough to permit the newly born fish to fall out of the spawning box into the aquarium. In this way the fry escape the voracious maw of the female.



A simple aquarium provided with heating facilities. This particular aquarium has a metal bottom. A U-shaped copper tube is soldered as shown. Heat is applied a short distance from the deepest bend.

The breeding season of toy fish is not restricted to any particular time of the year or to any one season. Spawning often takes place a number of times a year. With the small life-bearing tooth carps as many as thirty young may be born at one time, and breeding may take place as often as about once every four weeks. The number of times a fish may breed is largely controlled by the temperature of the water. Warm water hastens breeding, cold water retards it. Although most of the fish described are expensive, at first cost, they soon pay for themselves in a short time and even provide a handsome profit for the amateur aquarist who is able to dispose of his surplus bred stock.

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Unveiling the Mysteries of the Far East

(*Continued from page 297*)

pled with abstruse problems and posers from the ancient classics, none of which was less than three thousand years old. Of these a profound knowledge was demanded, down to the smallest detail.

The candidate was thoroughly searched before entry to his cell to ensure that he possessed nothing that might assist him in the coming ordeal. He was then locked in and left there for

The blacksmith and his assistant.

the week or ten days of the examination, food and necessaries being admitted through a narrow grating in the wall.

The questions were such that many of the more highly strung went mad under the strain, for their arrival at the Supreme Examination under the chairmanship of the Son of Heaven was the achievement of years of intense study, and now the slightest mistake in composition, or the least fault in placing a character, would floor the candidate for all time, since he was debarred from ever presenting himself again. When we realize that the least deflection of a character, the addition of a tiny and almost imperceptible stroke, may alter the entire meaning, we can appreciate to some extent the problem a Chinese student was up against.

Whatever may have been the defects of the examination system, it at least assured that an official should be a profound student and a master in style and penmanship. Strange as it may seem, a Chinese official is far more influenced by the manner in which a case is presented than by the merits of the case itself, and an indifferently worded letter or despatch at once prejudices the recipient against the writer, so high is the standard of literary appraisement, a standard that still obtains, for old ways and customs die hard in China.

It may be asked how this vast empire with its four hundred different dialects managed to remain united through the centuries. The answer is to be found in the Chinese method of writing by word pictures instead of letters. Although there are, for instance, eighty separate dialects in the one province of Fukein, every fairly educated Chinese can read the written language. In each dialect the word picture is represented by a different spoken sound, but the picture means the same thing in every part of the country, just as the figures 800 convey the same meaning to a Frenchman, a Norwegian or a Brazilian, who would not understand you if you said "eight hundred." The Chinese language, as evolved by the wise men of that empire, is certainly a notable contribution to the science of communication.

They were not only astute at inventing a wonderful language, but were mighty builders as well; the Great Wall is the mightiest barrier ever built by man and has guarded the northern frontier of China for twenty centuries. Astronomers tell us that the Great Wall is the only thing on earth that would be visible to the eye from the moon. Some idea of its stupendous size may be gained from the fact that it would stretch from New York to Kansas City, and that if all the material of which it is built were put into a wall measuring nine feet high and three feet thick, it would go completely round the earth.

Half a million men, soldiers, prisoners of war and criminals, were pressed into the service of construction; how they accomplished their task, in the face of immense physical obstacles, remains a scientific mystery to this day. Occasionally when appalled by precipitous mountain ranges and dizzy heights the workmen went on strike, but it was merely temporary, for one or two of their number would be cast into the interior of the wall as a sacrifice and a warning, and the work went on.

In other fields the Chinese have achieved similar success, notably in dentistry. The ordinary Chinese doctor and dental surgeon is an anachronism, but those who have given their lives to the study of the frailties and imperfections of this human frame have wonders to reveal which European practitioners would give anything to possess. The Chinese super-dentist claims to have the secret of a powder that, when applied to the teeth, does not deprive the patient

The portable restaurant. He carries it on his back.

of his senses nor cause him any inconvenience, yet enables the tooth to be withdrawn by the thumb and finger without the least pain and with no exertion on the part of the dentist.

On the other hand, there are many curious examples of the surgeon and the doctor in this land of wonder and mystery. The ordinary type of medico maintains that the body is divided into squares, each one of which has direct relations with some particular organ. There are three hundred and sixty-seven such squares and each disease or complaint must be treated through the square to which it refers. If it is in the loins, the small of the back, or the stomach, the square of that part must be pierced by a needle, usually red hot, and so the Chinese doctor goes on puncturing his patients until he either recovers or succumbs to the ordeal of fire.

I once had a servant who suffered from fever; he consulted his medical attendant who promptly punctured him in the neck and down the back; either the shock of the red hot needles drove the fever out, or my man decided it was better to get well whilst the prospects were bright, for the doctor in search of a cure was determined to go on puncturing in front as well as behind.

Science and invention find congenial ground in China, for the Chinese are essentially a peace-loving and law-abiding people, always anxious to avoid coming into contact with the law. Should they be involved, money is at once their first appeal, and the means by which they can extricate themselves from an odious situation. A Chinese must preserve "face," to quote the local expression, the most powerful and far-reaching in the language, and one that the people put above all else. There are ways and means of saving one's "face"; for instance, a merchant of local standing was accused of complicity in the opium traffic. For him to have been beaten, the punishment for this particular offense would have entailed a loss of "face" that could never be retrieved, so drastic action was indicated—a substitute must be procured. This is not a difficult problem, for in every Chinese town there are men who gain a livelihood by serving terms of imprisonment, or receiving the strokes awarded to another. So the merchant secured the man he was in need of, the police in turn were put in a happy frame of mind, for negotiations made it worth their while to metaphorically look the other way. The case came up for hearing and was duly disposed of, justice was done—at any rate by proxy, and the world went on as before. A percentage of the money that passed would find its way into the pockets of the magistrate, who had originally purchased his appointment for several thousand taels. He would, after all, be merely recovering the latter expenditure by degrees, and everyone would look upon him as an anomaly if he did otherwise.

Despite all the curiosities and anomalies with which China teems, the country is waking up. The civil war, important and ruinous though it is to foreigners, only affects a tiny part of this colossal land of four hundred millions. The rest carry on life as it has been lived for thousands of years, and will continue to do so long after this and other generations yet unborn have passed

Electrical Principles from Easily Performed Experiments

(*Continued from page* 321)

is found to be not at all critical.

Exactly what happens when a device such as an electric iron, which uses a large amount of current, is plugged in on the lighting circuit and blows a fuse, is very nicely illustrated by an easily performed experiment.

A block of wood supports by two tacks two pairs of paper clips separated about an inch from each other. Between one clip of each pair is threaded a small strip of "tin" foil, ⅛ inch wide. The remaining clips are used to make contact with 110-volt wires. The little fuse block which you have just made is equivalent to the screw type fuses in your cellar switch box. Place a 110-volt lamp in series with the fuse wire and connect the whole to the 110-volt lighting circuit. The fuse will, no doubt, carry the "load" or current. Now if a device such as an electric iron is also placed in parallel in this circuit, by plugging it into a socket connected across the lamp, the little tin foil fuse wire will "blow" or melt, thus breaking the circuit.

If an iron-cored coil is connected across in parallel with a flashlight bulb and the combination connected to a battery of several dry cells, the lamp will light if its resistance is less than that of the coil. If the current is suddenly broken, the lamp will momentarily light very brightly, almost burning out, because on the breaking of the current the magnetic lines of force formed about and within the core of the coil collapse, or disappear, which creates an *induced current* or induced electro motive force (e.m.f.) in the coil which current in turn flows through the light. This induced current is much greater than the battery current, so the lamp lights brighter.

If the preceding experiment is carried out using AC (alternating current), many queer effects can be noticed. A toy transformer (which can only be operated on AC) is made to light a Christmas tree lamp. A coil of wire with a hollow core is connected across the lamp. The lamp will generally not light, as its resistance will probably be greater than that of the "ordinary" coil. If an iron rod is introduced into the hollow core of the coil of wire, the lamp will gradually light, owing to the iron rod becoming magnetized, forming an *induced* alternating current in the coil, which bucks or opposes the existing current coming from the transformer terminals. This method of controlling the output or low voltage side of a toy transformer can be used in a practical manner.

The solid iron rod will become very hot in about a minute, due to stray or *eddy-currents* being set up in it. It will be found that if a bundle of many iron wires is used instead of the solid rod, those currents will not be produced to such an extent and the coil will not become hot.

Heating a wire increases its resistance.

An End Table and Sewing Basket from Discarded Spools

(*Continued from page* 320)

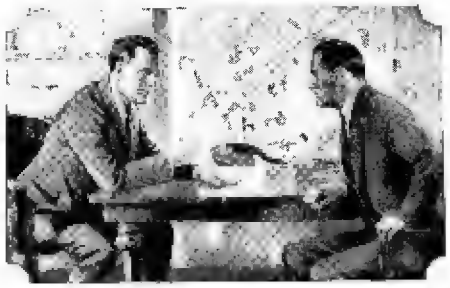
the lines of the Priscilla cabinet that comes down to us from early American days. The semi-circular shelves on the ends should have small dowels set into them to hold spools of thread. A pin cushion may have a place on one of these, and there may also be a place for the thimble and scissors. If the builder wishes to do so he can add a half length tray to slip inside the basket compartment.

The legs and the handle are made of spools. The handle, however, has a plain center section that may either be turned, or cut out and smoothed up by hand. It must have a hole bored through it lengthwise to accommodate the rod which holds it securely fastened to the spools at both ends. The ends of the rods with the nuts are countersunk into the end pieces and the holes plugged just before you stain the piece.

It is not safe to give specific dimensions on a project of this sort, for the proportions will vary somewhat with different sizes of spools. The dimensions as given, however, will serve as a pretty fair guide, and little difficulty should be experienced in making the different parts fit together. The construction of the frame of the sewing basket is very similar to that of the table, and it is hardly necessary to go into the details of this.

For the ingenious person there are many other applications to which spools may be put in the building of furniture; and where a turning lathe is not available they are particularly of use in giving the effect of turnings without the cost or labor involved in real turned work.

The spools will take almost any finish that one may wish to use on them.



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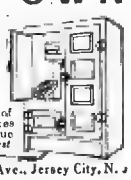

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Pearls—The Bane of an Oyster's Existence

(*Continued from page 287*)

all that I could see at first was an opaque glimmer, pale green in hue and as easy to pierce as a sea fog. Everything looked distorted and unreal and so out of proportion that things that appeared at first very near got farther away as they were approached. Even the tapering sea weeds staggered badly and the corals and other deep sea growths seemed to be shaking violently.

I managed to fill my basket and secure some of the young oyster shell species that were so useful in our investigations, but I do not mind admitting that I was glad to give the signal to be hoisted up. I got to the foot of the ladder safely, gripped it hard and paused for a moment, and then commenced to ascend. When I finally came to the surface and was hauled aboard, I decided that, after all, I would leave the diving in future to the more experienced native divers.

Among the investigations made was one to ascertain the real development and peculiar habits of the most important mollusk, as well as the natural habits of the mother of pearl specie, the *Melegrina Margaritifera*, the kind so universally found. In my catch I had brought in some true young pearl shells that I had found anchored or attached to some coral bed, and which turned out to be of the real *Margaritifera* species. The smallest measured not more than ¼ inch, and the largest 2¼ inches in diameter.

Many of the pearl divers contended that these pearl shells remain permanently fixed to the ocean bed through every stage of their existence, while others were of the opinion that the shells had no means of attaching themselves, but remained permanently quiescent in their selected habitat. Another section again tried to prove that the pearl shell was a migratory animal that was constantly moving from place to place. If this last theory were correct, all attempts at artificial cultivation would be futile, which view is supported by that of the most eminent authorities on this subject.

None of the aforenamed theories was found to be in precise accord with the facts. By a fortunate coincidence, an official of the Department of Fisheries had joined the fishing party. He had come to get information appertaining to this question, and needless to say I stuck tenaciously to this man, who knew more about oysters and other shellfish than the author of this article will ever know in a hundred years. The official commenced to examine the oysters that I had brought in, and the smaller species were kept alive in an aquarium in which the seawater was renewed every day. The little pearl shells adapted themselves with remarkable alacrity to their new environment.

From what I learnt, these pearl shells possess the faculty of ejecting a portion of the anchoring cable, so to speak, with which they are attached to the coral rock, which anchoring cable remains embedded in their tissues. These oysters are able to secrete an entirely new anchoring cable, which is surely a novel product of nature. It is secreted one thread at a time, and is of a greenish glossy hue, with at least forty strands or threads which harden in water. It was clearly demonstrated that the pearl oyster, when young, attaches itself firmly to submarine objects by means of an anchoring cable, so that in the event of injury to the cable, the old or primary one can be ejected and a new one secreted.

Typical pearl fishers and their boats.

After the most promising beds are stripped, each boat having a fishing capacity of some twenty thousand shells per day, the catch is taken to the shore by the special boats used for that purpose. The shells are then dumped on the beach, where they are left to rot, in order to better extract the pearl from the oysters. Then they are rinsed in water to remove the decaying organic matter, and the coveted pearl, if present, can be readily picked out. The washing itself is a most hideous and disgusting process. The process is aided, so to speak, by a vast number of mosquitoes and flies of all sizes and colors. It can be readily understood that these abominations tend to infect the whole camp surrounding the pearl fishing area. The residue is either dumped into the ocean or used as fertilizer by the native husbandmen. The stench, as I said at the outset, can be smelled for miles away at sea, coming up the wind. It is so strong that it clings to one's clothes, getting into the throat, where it remains to flavor everything that one eats and drinks. It is so strong, as a matter of fact, that it even recurred to me months later at the mere sight of an oyster.

At this juncture it might interest the reader to know something of the oyster itself, and the formation of the pearl, which latter is popularly supposed to have as its nucleus a grain of sand which in time becomes coated with a nacreous layer or mother of pearl, applied by the oyster. This conjecture has gradually come to be regarded as a fact. The true pearl has no connection with the shell, but is a so-called diseased limesalt or stone substance, seemingly grown from parasites, originating in a small sac of humour (or animal fluid) and gradually becoming gelatinous in concentric layers. In its center we find a cavity, holding organic matter that in reality is the remains of the parasite that gave the pearl its birth.

It is a curious fact that the pearl oyster (not unlike the case of the famous Strassbourg goose, or that of the formation of ambergris by the whale) becomes of special commercial value only after it has developed a certain condition of organic disease. In this connection it is of additional interest to note that the divers told me that they usually found the larger pearls in diseased or dying oysters. The opinion seemed unanimous that the probability of finding pearls was always greater when oysters were found crowded together. Thus, as is the case with mankind, overcrowding and generally unhealthy living conditions seem to promote diseases; but in the case of oysters, their hard luck is man's good luck.

The oyster shell consists of three layers, the outer shell, the center layer,

and the mother of pearl or nacreous layer. The mother of pearl or inner strata forms the normal lining that pearl shells have in common with other bivalve molluscs. A great difference exists again between the true pearl and the mother-of-pearl pearl, the latter originating in the inner portion of the shell in a manner similar to the real pearl. It is caused by objects that have slipped between shell and layer. The pearls originate in the interior tissues of the oyster, while mother-of-pearl pearls are produced by the fleshy flap that lines the shell. Although it is generally assumed that pearls are formed around some intrusive foreign body that is thought to be inorganic, this is not always the case, as the nucleus that is so necessary to produce a pearl is the larva of some highly developed or organized green parasite, whose life history is unfortunately too complicated to be well known to us.

Pearl formation is rather a complicated affair, but the process may be summed up in a few words as follows:

A small bubble filled with a fluid surrounds a parasitic organism. The fluid condenses and changes into organic shellstuff which then assumes the shape of concentric layers, with layers of lime between. The pearl is attached to the shell by means of a little stem, and as the pearl increases in size the shell cannot close any more, the oyster dies and the pearl drops out and is lost. Hence the reason why dying oysters contain the largest pearls.

Color has much to do with the value of the pearl. Hence the most highly prized ones are those with an iridescent sheen which come from perfect oysters, while the bivalves that live in a bilious state bring forth a pink pearl, and those suffering at times from fever produce a black pearl. Shells and pearls alike reach their greatest maturity after four years, when they can be considered ripe, while the oysters die after seven years.

Certain pearls are said to be of the breeding kind. That is to say, there are pearls that possess the power of germination. This has been corroborated by those widely known gem experts, Kunz and Stevenson, who claim that "if a few pearls are sealed up in a box together with some grains of rice and cotton wool, they will increase in size and number."

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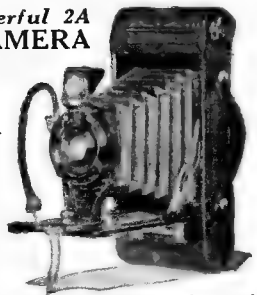

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32x4½	3.20	1.45	30x5.00	2.95	1.35
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34x4½	3.45	1.45	30x5.25	2.95	1.85
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In the August Issue of
Amazing Stories

SUBMICROSCOPIC, by Capt. S. P. Meek, U. S. A. If by some means, scientific, of course, one could transport himself to another atom -or world—what would he be likely to find? If Einstein is right that all things are relative, then size is, too. In other words, if we should be reduced in size, and the world we go into, should be proportionately smaller, then we would not feel or see the difference in size. Capt. Meek, in this story, touches on a somewhat new field for him and he gets an exceedingly happy result as you will agree, after you have read this story.

THE TIME HOAXERS, by Paul Bolton. Here is something different -an unusual time-story, treated in a unique manner. Every generation leaves its documentary records—some in the form of hieroglyphics carved in stone; some in the form of pictures, etc. And perhaps in the future, newspapers will be just as much an oddity. Our new author has ingeniously woven his theme into a thoroughly novel sketch. We are glad to welcome Mr. Bolton to our group of authors.

SPACEHOUNDS OF IPC, by Edward E. Smith, Ph.D. (A Serial in three parts) Part II. Almost anything that can be said about this story will be superfluous to those who have read the first instalment. There seems no limit to the doctor's ability to do better and better. These chapters are fast-moving, thrilling and full of science.

THE SUPERMAN, by A. H. Johnson. Because we felt sure that "The Raid of the Mercury" would be hailed as a gem, we are giving the sequel to the story before too much time elapses. Because this story is much longer, the author avails himself creditably, of the opportunity to elaborate on some very startling scientific ideas.

THE FORGOTTEN WORLD, by E. Bauer. Crowded out of the last issue.

And other unusual scientific fiction

A Revolving Self-Server for Your Table

(*Continued from page* 319)

first four of the base. This is because the pivot hole and the bearing groove must coincide with the pivot post and the groove of the pivot piece.

The height lines are located. Measuring from the face already marked, mark a distance 1¼″ from it. This is the only height line used. Placing the work in the lathe, mark these circles in the same manner used for the base. The pivot post is now cut, being finished smooth with sandpaper. Follow this by cutting the upper ⅜″ bearing groove 3/16″ deep. At this time, test these cuts to see that those of the base and those of the pivot piece coincide. Place a number of the ball bearings in their base groove, and fit the pivot post in the pivot hole. See that the pivot piece moves freely on the base, and that the depth of the bearing grooves allows the pivot piece and the base to fit within 1/32″ of each other.

The edge of the pivot piece is now rounded ½″, and the entire piece finished with sandpaper. The tray is now ready to be constructed.

The tray is shaped from a piece of stock having a 1¼″ thickness, and either 21″ square, or 21″ diameter. If the builder has a lathe which will handle such a size, it is turned to a 20″ diameter, and its bottom curved as shown in the plan. Note that this is not a complete curve, but that the center of the bottom has a 6½″ diameter circle which is flat.

If your lathe will not handle the work, the circle is cut with a coping saw, and the bottom curve obtained with a plane. This piece should be finished with sandpaper until a satin surface is obtained. The server is now ready to assemble.

The pivot piece is fastened to the bottom of the tray with 1¼″ wood screws, which are countersunk into the pivot piece. The pivot post is thrust into the base hole, and a 1″ round head wood screw and washer is used to hold it in place. This is screwed from the bottom of the base into the end of the pivot post. Countersink the screw and washer, and do not fasten too tightly, as the tray and pivot piece move this screw around with them.

If wood requiring other than a natural finish has been used, paint the server when the base and the tray with its pivot piece are separate. Do not allow paint to enter the groove of the bearings, as it will retard the ease with which the tray turns.

After finishing has been completed, cover the bottom of the base with green felt, attached with carpenter's glue, and this handy self-server is ready to go to work.

Plants That Act Like Humans

(*Continued from page* 285)

like ovipoiter into the soft tissue of the pistil and there lays the first egg. No sooner is the egg laid than the moth runs up to the top of the pistil and thrusts the ball of pollen into the stigmatic funnel and so makes sure of the fertilization of the seed. Two or perhaps three eggs are laid in the same pistil, but always a fresh ball of pollen is used to make sure of the proper development of the egg. The grub hatches in about a week and it finally enters one of the developing ovules or seeds. Here it lives happily, undergoing certain stages of growth. Just about the time the seeds are ripening the grub bores a way out through the pod and makes its way to earth where it turns into a chrysalis, finally to emerge as a perfect moth.

The case of the yucca and the pronuba moth is one of the most curious in the world of nature. Both insect and plant are dependent on one another. Experiments have shown that the yucca cannot produce seeds without the aid of the moth, and certainly the little moth could not find food for its grubs save in the seed of the yucca.

Even plants have indigestion, it appears, and tend to rid themselves of unwanted matter which they may absorb through their roots. Now and again growers of bamboos, if they split up the canes, will find small rounded stones at the joints. Similar stones may, on occasion, be found in coconuts. In appearance these stones are not unlike dull pearls and they are always extremely hard. As a matter of fact they represent an excess of mineral matter taken up by the plant. In the case of the bamboo the stone is formed of silicate substance and is as hard as flint. Stones found in coconuts have been declared almost pure carbonate of lime.

Do some flowers function as weather bureaus and issue storm warnings to their fellows by emitting light signals? At any rate, on a warm night it is always worth while to look in a garden for luminous flowers. Flowers that give out light include nasturtiums, topelum, marigolds, evening primroses and helianthus, but there are many others. At such times the blossoms appear to be giving out myriads of brilliant but very small sparks, which die away almost as soon as they appear. It is believed that the light is of electrical origin, for it is most in evidence some hours in advance of a thunderstorm. Thunderstorms mean very heavy rain, and it is conceivable that, warned in advance, some delicate blossoms may be enabled to take steps to preserve themselves from being crushed entirely out of existence by the downpour.

Science and Invention Announces the Fourth Prize Winners of the $3,250 Ideal Home Workshop Contest

E. Austin Rice, Fourth Winner in the $400 Class, says:

I WAS born in Massachusetts in 1896. Attended grade and high schools in Boston. Went to Northeastern University studying electrical engineering for three years and left to go to M. I. T., but the war interrupted my studies.

E. Austin Rice

Spent twenty months in the Coast artillery with six months overseas. Am now a captain in the Officers' Reserve Corps.

Returning, I attended M. I. T. for a time, but decided to accept a position with a tractor manufacturing company in Peoria, Ill. Later held positions with two rubber companies. This was followed by a year with Charles A. Levine, engaged in salvaging surplus and obsolete government ammunition. During this time I married and at the present time have two children. When the salvage work was completed, I went with a large steel company in Youngstown, Ohio, where I remained for several years. Am now employed by a company manufacturing pig iron and coke in Chicago and other cities.

In the line of sports, golf and tennis are of most interest to me. My hobbies are photography and radio. I have always had a love of good tools, which prompted me to enter this contest and winning such a set is fulfilling one of my ambitions.

Why Mr. Rice Chose the Tools He Did:

On first thought I believed that it would be impossible to select a complete quality shop for $400, but after spending a great number of hours poring over catalogs and calling on hardware dealers, I found that I could select a real, honest-to-goodness set of machine and hand tools, without sacrificing quality for completeness or price.

My list as submitted contains the necessary tools and machines which will enable me to make almost any kind of furniture, make repairs to anything about the house, build models of all kinds and in fact, do any task that the home mechanic and lover of good tools can conceive.

I have endeavored to make the work performed by any particular line of tools as complete as possible. For example, in selecting wood drills and bits, I will be able to bore any size hole from 1/16″ to 3″ by very gradual steps. Likewise, the list contains four different boring tools. Files, screwdrivers, chisels, etc., were similarly selected.

The power tools selected will enable me to perform many tasks that would be very tiresome or impossible by hand methods. There are other power tools on the market, but those selected are, to my mind, the essential units of the ideal home workshop. I chose a countershaft driven set because of the ease of shifting work from one machine to the other, as well as making it possible to drive the entire shop with one motor.

The main elements of this shop should be good for a lifetime with due and proper care, which such a wonderful outfit deserves.

With the ideas and sugggestions offered by SCIENCE AND INVENTION, one can spend many an enjoyable and profitable hour with this set of tools. To own such a shop has always been one of the ambitions of my life and if I am fortunate enough to win, you may be assured that the tools will be in the hands of one who knows the joys of ownership and the pleasures that come from the creation of such things as are possible with a real set of tools.

E. Austin Rice's List of Tools:

Quantity		Price
1	Lathe, complete, 7″-40″ centers	$21.50
1	Tee Rest with 2 shanks, 12″	1.60
1	Extra Holder for tee rest	1.60
1	Screw center face plate, 4″ dia.	2.00
1	Sanding disc, 8″ dia.	2.25
1	3-Step cone pulley for motor, ¾″ hole	2.00
1	Universal handsaw, complete, 9″-7″ saw	30.50
1	Rip saw for above, 7″ dia.	2.50
1	Arbor attachment for above	1.50
1	Boring table, complete for above	8.00
1	Extended Rip Guide for above, 18″	2.75
1	Geared chuck for above, 0″ to ½″	12.50
1	Dado head set for above, 5″ dia.	13.75
1	Band saw, 12″	32.50
1	Universal jig saw, 10″	12.00
12	Jig and fret blades, assorted	1.65
1	Jointer, 4″	25.00
1	Safety guard for above	2.50
1	Special moulding cutter, ¾″ hole	14.50
1	Motor, ½ H. P., 60 cycle, 110 volts	31.75
9	Feet shafting, ¾″	4.50
4	Bronze bearing shaft hangers, ¾″ hole	6.00
2	End collars, ¾″ hole	.80
1	Flexible coupling, shaft to motor, ¾″ hole	1.50
1	Flat pulley, 1½″ dia., 1¾″ face, ¾″ hole	1.25
1	Flat pulley, 2½″ dia., 1¾″ face, ¾″ hole	1.25
1	Flat pulley, 3½″ dia., 1¾″ face, ¾″ hole	1.50
1	Flat pulley, 4″ dia., 1¾″ face, ¾″ hole	1.75
1	Endless belt, 45″ x 1¾″	1.00
3	Endless belts, 45 x 1½″	3.00
1	Round belt, 48″ x 5/16″	1.50
1	Router bit, ¼″	1.90
1	Router bit, ⅜″	1.90
1	Router bit, ½″	1.90
1	Machine bit, wood, ¼″	.80
1	Machine bit, wood, 5/16″	.80
1	Machine bit, wood, ⅜″	.80
1	Machine bit, wood, 7/16″	.80
1	Machine bit, wood, ½″	.80
1	Buffing wheel, 8″ x ¼″-¾″ hole	.40
1	Wire scratch brush, ¾″ hole	.75
1	Emery wheel, 5″ x ¾″-¾″ hole	1.50
1	Spear point turning tool, ¼″	1.25
1	Round point turning tool, ¼″	1.15
1	Round point turning tool, ½″	1.15
1	Square point turning tool, ¼″	1.15
1	Square point turning tool, ½″	1.15
1	Gouge turning tool, ¼″	1.25
1	Gouge turning tool, ½″	1.25
1	Skew turning tool, ¼″	1.15
1	Skew point turning tool, ½″	1.15
1	Skew turning tool, 1″	1.50
1	Parting tool, ½″	1.15
1	Woodworker's vise	$ 8.50
1	India oil stone, 2 grits, 6″ x 2″ x 1″	1.50
2	Wood clamps, 10″-6″	4.00
2	Steel bar clamps, 36″	5.00
2	"C" clamps, cabinet, 5″-2¼″	1.20
1	Outside calipers, 6″	1.00

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1	Ratchet bit brace, 10 in.	3.00
1	Countersink with guage	.60
1	Dowel sharpener	.45
1	Screwdriver bit, ¼" in.	.25
1	Screwdriver bit, ½"	.25
1	Adjustable bit guage	.90
1	Handdrill with drills	3.90
1	Breast drill	5.75
1	Set bench wood bits (13) ¼"-1"	6.50
1	Expansive bit, ⅞"-3"	2.17
1	Set twist drills (29) 1/16"-½"	9.60
1	Bed rock jack plane, 14 in.	5.35
1	Block plane	2.50
1	Spoke shave	.75
1	Nail hammer, 5 oz., size 4	1.35
1	Nail hammer, 16 oz., size 1½	1.65
1	Machinist hammer, 16 oz., size 0	1.25
1	Ripping bar, 30"	.90
1	Bevel edge firmer chisel, ¼"	1.30
1	Bevel edge firmer chisel, ½"	1.45
1	Bevel edge firmer chisel, ¾"	1.55
1	Bevel edge firmer chisel, 1"	1.70
1	Scratch awl	.40
1	Std. head screwdriver, 2½"	.30
1	Elec. head screwdriver, 4"	.40
1	Std. head screwdriver, 6"	.60
1	Std. head screwdriver, 10"	.90
1	Ratchet screwdriver, 8"	1.20
1	Offset screwdriver	.40
1	Nail set, 4"-5/32" tip	.20
1	Center punch, 4"-⅛" tip	.20
1	Hand cold chisel, 5½"-⅜"	.45
1	Hand cold chisel, 7½"-⅞"	.80
1	Cape chisel, 7"-⅜"	.65
1	Round nose chisel, 7"-⅜"	.65
1	Machine punch, 8"-½"-3/16" point	.40
1	Thin nose pliers, 6½"	1.10
1	Slip joint pliers, 8"	1.25
1	Ex. hvy. electrician pliers, 7"	2.50
1	Long square reamer pliers, 6"	1.40
1	Hack saw frame	1.25
12	Hack saw blades, flexible, 10"-14T	.60
12	Hack saw blades, flexible, 10"-24T	.60
1	Mill file, R.E. bastard, 10"	.29
1	Flat file, 2nd cut, 4"	.20
1	Hand file, smooth, 8"	.31
1	Hand file, bastard, 10"	.35
1	Flat file, 2nd cut, 8"	.28
1	Round file, 2nd cut, 9"	.27
1	Square file, 2nd cut, 8"	.29
1	Half round file, bastard, 10"	.42
1	Slim taper file, single cut, 8"	.21
1	Half round dead float and wood file, 10"	.50
1	Half round wood rasp, bastard, 10"..	.63
1	Cross cut hand saw, 24"	3.75
1	Rip hand saw, 24"	3.75
1	Back saw, 10"	1.71
1	Compass saw, 10"	.78
1	Comb. glass cutter and putty knife..	.39
1	Tinner's snips, 8"	1.45
1	Pipe wrench, 10"	1.25
1	Double end wrench, 6"-8"	1.75
1	Electric soldering iron, ⅞" tip	4.10
1	Swivel base vise, 3" jaws	5.40
	Total cost of shop	$400.00

C. Howard Green, Fourth Winner in the $200 Class, Says:

I WAS born in Sunol, California, on December 15, 1901.

When I was very young my parents moved to Oakland, California, and five years later moved to Stockton, California, where I attended school. At an early age I left school to learn the machinist trade at which I have worked steadily until just recently.

C. Howard Green

My interest in machinery and mechanical devices dates back to early childhood. My earliest recollections are of making toys for my sister. It has always been my ambition to complete my workshop for it still remains my foudest hobby, and I wish to assure you that your award is no little appreciated.

In 1923 the family moved back to Oakland, California, where I attended the Evening High Schools to study mathematics, and for the last four years have attended continuously.

I am married, and since January 1, 1921, I have attended the Boeing School of Aeronautics at Oakland Airport where I am taking a master mechanic's course.

Why Mr. Green Chose the Tools He Did:

Were I to equip a home workshop and had $200 with which to do so, I would select the equipment mentioned in the enclosed list.

Because of the many uses and the variety of work done on a circular saw I selected the described molding cutter attachments. The saw table has a more accurate rip gauge and the table raising features are the best I have seen. The emery wheel attachment is very handy in keeping the shop tools in cutting order.

Some wood turning lathes are superior to others on the market in that they are more rigid and have ball bearing thrust headstocks. The sanding attachments are ideal for numerous jobs, as for squaring up work.

The band saw selected is one of the most complete and sturdy that I have yet seen. The tension device is unequaled and the disc wheels are better balanced and lighter in weight.

The scroll saw is the ideal saw for any small work. The compactness of it makes it advantageous.

A 2 shaft 1/3 H. P. motor operates the group of machines above mentioned. With two pulleys on either side of the motor it takes care of the four machines very nicely.

The machinist vise I selected for its sturdiness. One always has a variety of uses for a good vise.

The rest of the miscellaneous small tools are too numerous to mention individually, but I believe they form a fairly complete set of tools for the home workshop.

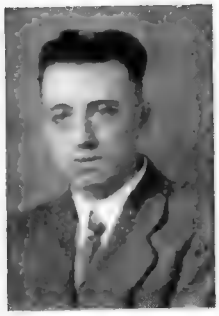
C. Howard Green's List of Tools:

Equipment	Price
1 Six-inch circular saw	$21.25
1 Set moulding cutters for circular saw	15.00
1 Emery wheel arbor for cir. saw	1.25
1 Four-speed lathe	24.45
1 Belt for lathe	1.25
1 Four-step pulley for lathe	1.50
1 Combination boring and sanding table for lathe	5.00
1 8½" sanding disc	2.50
1 12" band saw	37.50
1 Pulley for band saw	.60
1 Belt for band saw	1.40
1 1/3 H. P. 2 shaft motor	16.00
1 Amer. scroll saw	10.00
1 Pulley for scroll saw, ½" bore	.50
1 Belt for scroll saw	1.00
1 ½" parting tool for lathe	1.25
1 ½" gauge for lathe	1.25
1 Mechanic's drill set	1.35
1 3" Machinist vise	8.50
1 6"Grinding wheel grain No. 60	1.16
1 Carborundum stone, size 5 x 2x ¾	.85
1 9" Combination square	2.55
1 Pr. 8" outside calipers	1.00
1 Pr. 6" inside calipers	1.05
1 Pr. 8" spring dividers	1.35
1 1/32 in. nail set	.15
1 3/32 in. nail set	.15
1 8" adjustable wrench	.95
1 Hack saw frame	1.25
1 Pr. 6" cutting pliers	1.00
1 Pr. 11½" tin snips	2.34
1 Pr. clamp fixture	1.25
1 Adjust. hand screw	1.15
1 Screw clamp	.35
1 Hand drill	.85
1 Can glue	.25

1 Scratch awl	.17
1 Sheet 2/0 garnet paper	.10
2 Sheets ½ garnet paper	.10
1 10" half round wood rasp	.50
1 10" sq. edge mill bastard file	.21
1 Hand saw 20" 9 points	2.85
1 Set auger bits	5.25
1 Polished 2 ft. steel square	2.70
1 Claw hammer, 16 oz.	1.85
1 Upholsterer's tack hammer	1.25
1 3 ft. 4-fold boxwood rule	.85
1 8" screwdriver	.70
1 3" screwdriver	.35
1 Bit brace, 8"	2.60
1 18" wooden level	1.30
1 ¼" wood chisel	1.10
1 ⅜" wood chisel	1.10
1 ½" wood chisel	1.20
1 ¾" wood chisel	1.40
1 9" Iron jack plane	3.40
1 Block plane (iron)	1.35
1 Countersink	.50
Total	$195.93

Thomas K. Waller, Fourth Winner in the $50 Class, Says:

BORN twenty-three years ago in Wichita, Kansas, I am the eldest son of a government inspector in the Department of Agriculture. My first years in grammar school were spent in the Salt Lake City schools. Then came years in the grade schools of Nebraska and Kansas. Moving to Fort Worth, Texas, I finished the grammar grades, including a half year in the manual training department which is the only technical training I have had in the use of tools, and entered North Side High School. After two and a half years there, I came to Memphis, and in nineteen twenty-eight received my diploma from Central High School.



Thomas K. Waller

As a member of the Boy Scouts I had part in many projects, notably the building of a full sized model of the old army post at Fort Worth. Later when a student at North Side High School I was a member of the "Stage Crew" which completely rebuilt the stage front and curtain mechanism.

I am a steady patron of the public library, averaging four books a week, and a thorough newspaper reader. I am interested in scientific research, mechanics, travel, politics, and literature. My uncles are master carpenters, and I have inherited their love of tools. One of my most valuable possessions is a file of radio and technical magazines dating back to nineteen twenty-three, together with a card index of over two hundred titles.

Why Mr. Waller Chose the Tools He Did:

The quality of my selection is attested by the character of the companies, practically all of whom have national or international reputations. The completeness of my list I leave to your judgment. The amount of money was set by you, and this I have not exceeded.

Believing that no man can be a good carpenter or mechanic who does not keep his tools sharp, and that certain tools are essential to any shop, I have listed my tools under three heads: "Tool Sharpening Equipment," "Essential Tools," and "Miscellaneous Tools." I have put the sharpening equipment first, and made it as complete as possible, considering the tools to be sharpened, so that the old axiom "Good work deserves sharp tools" may be obeyed.

No shop can operate without certain tools and these I have put into the "Essential Tools" list. Where it has been possible to make one tool do the work of several, without impairing its own value, I have done so. This is true of the "Combination Square" which combines eight tools, and the automatic screwdriver which combines two. I have tried to avoid duplication of tools but in the case of the automatic screwdriver it was more of an economy than a duplication since I had need of a light drill, however, the automatic screwdriver is too long for many purposes, and so two more screwdrivers were added to the list.

I have tried to keep all the tools selected within a certain price level because "one good tool cannot repair the damage of several poor ones," and since I was limited in the amount of money it would have been a poor policy to buy one or more very good tools and a long list of inferior ones.

I placed a tool chest in the "Miscellaneous List" so that proper care might be given the set of tools. I did not list a bench because I believe a bench should be built to suit the requirements and conveniences of the owner. A wrecking bar and an ax are not essential but are often in demand.

Thomas Waller's List of Tools:

Quantity		Price
	Tool Sharpening Equipment	
1	Hammer grinder	$1.00
1	Foot treadle	.25
1	Oilstone, combination, 6" x 2" x 1"	1.25
1	File, 8" mill, single cut	.25
1	File, 6" taper, single cut	.20
1	Saw set	2.00
	Essential Tools	
1	Saw, hand; 24" long, 8 point, skew back	2.25
1	Hammer, carpenter, 13 oz., size 2, 13" overall, adze eye, plain face, plain neck, and plain poll; curved claw	1.50
1	Hammer, tack; 4" head magnetized	.20
1	Brace, "Latch Pawl" ratchet, 10" swing	1.80
4	Auger bits, 4/16 @ 40c - ¼"; 8/16 @ 50c - ½"; 12/16 @ 70c - ¾"; 16/16 @ 90c - 1"	2.50
1	Countersink, rose type, ¾" cutting edge	.45
1	Screwdriver bit, 4½" long	.20
1	Screwdriver, automatic quick-return spiral ratchet for light work; can be used for light drilling	2.65
8	Drill points for automatic screwdriver, 1/16 to 11/64	.45
1	Screwdriver, ratchet, 5" blade	1.20
1	Screwdriver, ratchet, 2" blade	.65
1	Plane, smooth; 9" long, 2" cutter	3 95
1	Plane, block; 5½" long, 1⅜" cutter	.80
1	Steel square; body 24" x 2", tongue, 18" x 1½", brace	2.70
1	Combination square rule, try square, miter square, center square, scriber, level and plumb, height gauge, depth gauge	3.60
1	Bevel square, 6" blade, 4¼" iron handle	.85
1	Rule, 6 foot hook feature	.75
1	Gauge, marking and mortising; beech, brass screw, head plated, stop screw	1.05
4	Chisels, wood; bevel edge pocket, ¼" @ $1.10; ½" @ $1.20; ¾" @ $1.40; 1" @ $1.50	5.20
1	Chisel, cold; ½" blade	.30
1	Vise, woodworkers, jaws 4⅝", open 4"	3.00
1	Pair of pliers, 3 button's cutters and pipe grip	.90
1	Wrench, pipe	1.25
	Miscellaneous Tools	
1	Tool box, 17" x 8" x 8"	4.35
1	Wrecking bar, 24" x ¾"	.75
1	Hand ax	1.75
	Total	$50.00

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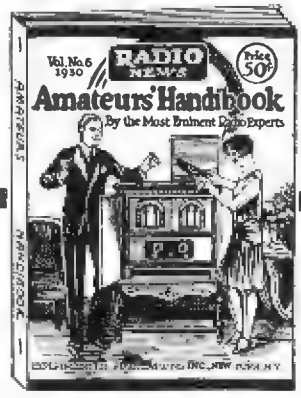

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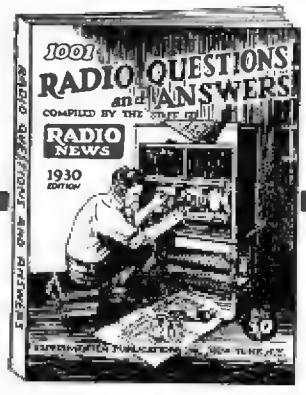

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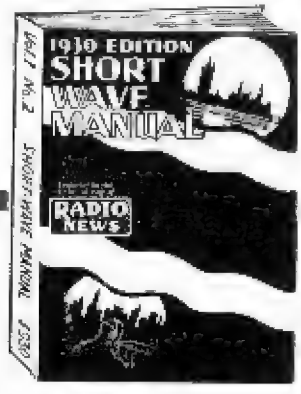

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Experiments Prove Aurora Theories

(*Continued from page 282*)

cular cross-sections are spread into planes. This produces the auroral "bows" or "curtains."

Outside the space free from electrons, towards the equator, are the periodical paths through space, of which a great many complicated forms have been found by mathematical calculations and by experiments. These paths in their combination, form an electron wall, far beyond the Heaviside Layer, which can reflect ultra-short wave signals coming from the earth, and which therefore has been regarded by Störmer as the cause of the recently observed "space echoes." As the electrons in these paths travel in the same direction with reference to the equator of the earth, they constitute an electric current, a circular current, which reacts upon the magnetic field of the earth, and among other effects pushes back the zone of the Aurora from the equator. This action can be shown experimentally with the aid of an artificial circular current.

Experimental models proving these theories were recently demonstrated in a Berlin laboratory during the course of a lecture on the Birkeland-Störmer theory given by Dr. Brüche, of the Experimental Institute of the General Electric Light Company of Germany.

There still remain to be explained the various colors which the Northern Lights produce. We do not know the exact composition of the outer atmosphere at the enormous heights at which the phenomenon occurs. It may be homogeneous, like the air at the surface of the earth, only very greatly rarefied, or it may be broken up into whisps and layers of the different gases which go to make up our atmosphere. If that proves to be the case, then the colors are easily explained by the fact that an electron stream, flowing through different gases, produces different color effects. We make use of this fact in modern gas discharge tubes, such as the neon tube used for signs. Again, it is known that in the outer limits of our atmosphere the temperature is extremely low, and it may be that the gases are solidified by the extreme cold into tiny crystals. When solid nitrogen is bombarded by an electron stream, a green color is produced at the point of impact.

One practical result of the investigations into the causes of the Aurora has been the development of the electron ray compass for use on board airships.

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Scientific Aids to Your Comfort

(*Continued from page* 315)

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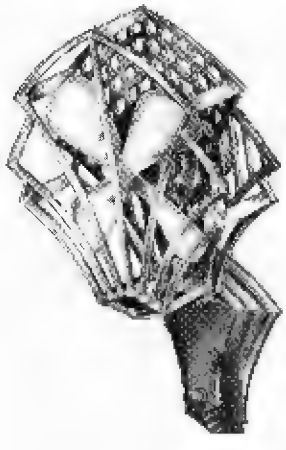
FANS are so common nowadays and have invaded so many apartments that it is about time an organization has put one on the market that harmonizes with the furnishings of a room that is decorated in the modern manner. The one illustrated is of even greater interest because it is manufactured by a company that is famous for the reliability of its products. The wall type mount and revolving attachment help to make this a most convenient and useful unit. Tested and approved in our laboratory.



Kitchen Multi-Fork

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The utensil is 12½ inches long, and made of nickel plated steel to insure durability. The handle is of enameled wood. Special attention has been paid to the clamp; it holds food or dishes in an iron grip. You need no longer worry about having hot potatoes or ears of corn slip from your hands. Tested and approved in our laboratory.

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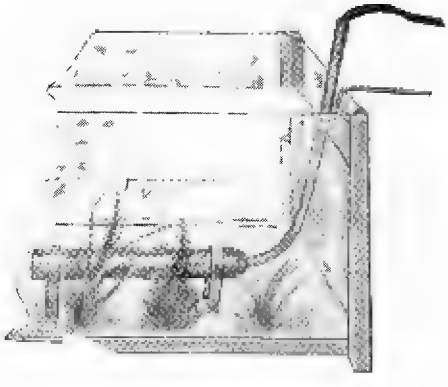

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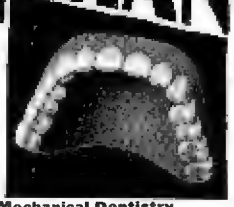

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Planes Trap Migrating Insects at High Altitudes

(*Continued from page* 300)

sieve from those air currents their contents of bugs. After a screen is exposed for 10 minutes to the air currents at a given altitude and the specimens collected, either the pilot or observer in the plane operates the control wire so that the screen is restored to the insectproof compartment.

The usual practice is for the birdman, accompanied by one of the federal entomologists as observer, to climb to an altitude of say 12,000 feet before the first screen is exposed. The pilot holds the plane at that altitude long enough for the exposure of one screen, flying forward at a speed of from 85 to 90 miles an hour. After the first specimen screen has been exposed, the plane descends to the 10,000 foot level, and the process is repeated. This program is continued until all the screens have been exposed. Therewith, the plane returns. The screens are then transported to the neighboring laboratory. The specimens are removed carefully from the sticky surfaces of the screens, placed in tiny vials of preservative, labeled and then are mailed to the National Museum at Washington.

A large number of the insects taken are crushed by the impacts when they strike the screen. The wind blowing at perhaps 50 miles an hour may carry the insects in the direction opposite to that in which the plane is traveling at a velocity of 85 miles an hour, so one might readily expect many dead insects in the trap.

The National Museum experts study the mangled remains of the bugs and piece them laboriously into position. The dead insects are then identified and classified. Question marks instead of scientific names have been recorded on the report in some cases for certain of the specimens caught in the upper air are unknown, and are the first of their kind ever examined by American entomologists.

The Samland scientists have ascertained that insect migration is of 3 different types: (1) Voluntary flight by the robust and strong-flying insects which are qualified to journey far propelled by their individual wing power, (2) Involuntary flight of the smaller, lighter, weaker and in some cases wingless bugs which are picked up by rising air currents caused by convection and carried to high altitudes whence they are blown here, there and elsewhere by dominant winds above the clouds and (3) Involuntary-voluntary travel by an intermediate class of bugs which tour partly under their own ability to fly and partly as "blind baggage" on the wings of prevailing breezes.

The dominant air currents above the clouds carry the light, small-bodied bugs until they are caught by descending winds which eventually may deposit them in strange fields in a foreign country far remote from their land of nativity. The economic danger associated with such insect migration features is the survival of rugged insects which withstand the vicissitudes of rigorous travel and establish themselves as pests in their new home. The effort is now to perfect an effective method of determining if the insect captured above the clouds was alive when snared on the airplane screen. Living insects are serious menaces and if such occur in the upper atmosphere, our national scientists will potentially have to perfect efficient methods of combating such Captain Kidds of food production. This may result in remarkable future warfare in the kingdom of the sky.

Iron-Banding a Box with Linoleum Straps

(*Continued from page* 317)

pieces were bent around the corners.

The upholstery nails are placed as shown in the illustrations. There is little need to measure for their spacing, as those on the leaves are centered on the petals, while the others, for the most part, are divided evenly between. However, none should be driven into the wood joints. A certain amount of irregularity, provided it is slight, makes the design more interesting.

If there are any open joints, fill them with putty or gesso, and chamfer the "angle-iron" corners lightly with a chisel and sandpaper, carefully smoothing flush any projecting edges of linoleum.

Surface the "irons" by tapping, from various angles, with a cross-peen hammer, changing the force and direction of the blows, and striking first with one corner low and then the other. Try to space these dents uniformly, but get as much variety as possible in direction and size.

The painting is very simple. If the wood has been wire brushed, pour boiled linseed oil into a small tin-can lid and mix with it a pinch of dry burnt umber. Brush this on the wood, giving one coat all over.

A good flat black paint is best for the irons. Apply with a narrow brush, holding the bristles rather flat, and drawing them away from the wood edge to avoid smearing the wood with black. Have ready an oily rag to wipe off any chance daubs, and cut around the leaves and corners with a small artist's brush. One coat is enough.

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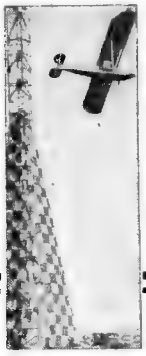

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RADIO NEWS
for August

Among the articles of general and also technical interest in this issue of RADIO NEWS are the following:

"How the Police Are Using the Radio Third Degree," by Samuel Kaufman.
"Searchlight Radio with the New 7-inch Wave," by E. E. Free.
"A Television Receiver Kit Easily Assembled at Home," by D. E. Replogle.
"A Pentode Auto Radio Receiver," by James Millen.
"A Set Tester You Can Make," by Bill Stella.
"Super Broadcasting on Long Waves," by Lieut. Wm. H. Wenstrom.
"Amateur Radio Aids Explorer," by Everett M. Walker.
"An All Wave Super Without Plug-In Coils," by McMurdo Silver.
"Bringing in Pictures with the Home Televisor," by Joseph Calcaterra.
"Receiving Short Waves on Your Present Receiver," by James Wilcox.

In addition there will be articles other than those listed above, as well as the departments, which include the Service Bench, Backstage in Broadcasting, Radio-Science Abstracts, What's New in Radio, With the Experimenters, Radio Physics Course, Latest Radio Patents, and Mathematics in Radio.

Changing Jobs to Keep Health

(Continued from page 281)

square peg in a round hole, change to another occupation which makes you chuckle with satisfaction. But if you are a follower of Venus and Bacchus, leading a short and merry life, don't lay your ill-health to your occupation.

Three of the great causes of industrial ill-health are lack of outdoor exercise, especially in occupations associated with constrained positions of the body; abuse of food and drink; and needless exposure to risks.

There are other industrial conditions over which the employee has no immediate control. His only recourse lies in concerted action to force protective legislation. Organized labor has accomplished much to better working conditions. It is both a humorous and a tragic circumstance that, when the stone masons went to build the Hygienic Laboratory in Washington, they had to refuse to work in order to secure sanitary living quarters.

It is only within the last twenty years that industrial hygiene has attracted wide interest in the United States. Though much has been done, it falls far short of approximating the high health standard in England and on the Continent. Many of our worst factories fail to fulfill even the minimum legal requirements in Europe.

The Goal We Hope to Reach

That good working conditions pay in dollars and cents has been demonstrated by Elliot Washburn with emery grinders in Massachusetts. By changing them from a badly lighted, poorly ventilated basement to a well lighted, airy workroom, their output was increased 30 per cent.

Man has been exceedingly ingenious in devising intricate machinery. Drastic federal and state legislation is focusing his attention on ingenious devices to mitigate health hazards in the dangerous trades.

Eventually stone workers, diamond cutters, metal grinders, flax and linen workers, and a host of similar workers, will no longer become asthmatic and consumptive through inhalation of metallic, mineral or vegetable fiber dust.

In addition to legislation, much has been done by a great body of laymen, the National Safety Council, founded in 1912 for the promotion of interest in the elimination of accidents and health hazards from American industry. William H. Cameron, one of its most devoted executives, has summarized its aim with the words of Juhnke:

"And the end is that the workman shall live to enjoy the fruits of his labor; that his mother shall have the comfort of his arm in her age: that his wife shall not be untimely a widow; that his children shall have a father; and that cripples and helpless wrecks who were once strong men, shall no longer be a by-product of industry."

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(While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.)

Answers and Prize Awards in May Puzzle Contest

First Prize, of $10, is awarded to: J. G. Kirkham Medora High School, Medora, Ind.

Second Prize, of $5, is awarded to: Joseph A. Ciccolello, 44 Barrows St., Albany, N. Y.

The ten prizes, of one dollar each, are awarded to the following:

Walter Homan, 2010 Malvern Ave., Dayton, Ohio.

F. R. Schneider, 3809 Fifth Ave., Pittsburgh, Pa.

A. P. Herff, 110 Broadway, San Antonio, Texas.

Howard Hanthorn, 119 North 9th St., Corvallis, Ore.

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E. F. Kirtland, 179 Taylor Ave., Beaver, Pa.

Thomas A. Ahroon, Ensign, U. S. S. Pennsylvania, c/o Postmaster, N. Y. City.

John F. Kyes, Jr., Box 271, West Boylston, Mass.

Mrs. Frank Zuck, 33 Girard St., N. E., Washington, D. C.

Ancher Julius, 913 Maple St., Des Moines, Ia.

Solution to "New York's Air Derby"

The race of three airplanes might have terminated in twenty-six varied results as follows:

Assuming that all three finish—A, B, C; A, C, B; B, A, C; B, C, A; C, A, B; C, B, A.

Then A, B, C, in a dead heat: or, A, B; A, C; or B, C, in a dead heat for the first place. Then again, A first with B, C, in dead heat for second; or B first with A, C tied or, C, first with A, B tied.

Then there are various results in which one or more of the planes fail to finish. All three might fail to finish; then there are nine different results in which one plane failed; and with two failing to finish there are three ways. So far as the outcome of the race is concerned, a plane is either first, second or third, out, or tied.

Solution to "A Puzzle in the Woodpile"

The 8-foot log required five cuts to produce six 16-inch lengths, whereas two 4-foot logs required but four cuts to produce six pieces. Therefore, the hard cord was a 25 per cent bigger job, irrespective of the difference in sawing time between the two kinds of wood.

On the basis of charges for the respective cords, the time for sawing the soft wood as compared with the time for sawing the hard wood, would be as 240 is to $\frac{1200}{1\frac{1}{4}}$, or 1 to 4. Assuming that it takes the man three minutes to saw through a log of soft wood, then it will take him twelve minutes to saw through a hard log of similar circumference.

Solution to "Flying the Mail"

Let us call the time at which the planes will be closest together on the line of the hypotenuse of the right triangle formed by their routes, O. Since the planes travel at constant rates of speed, their approach and departure from O will be uniformly gradual. In other words, one hour before they reach O, they will be the same distance apart as they will be one hour after passing O.

At the start the planes are D miles apart

$$D = \sqrt{280^2 + 240^2} \quad D = \sqrt{136000}$$

Traveling for X hours, until again the distance between them is D, then—

$$\sqrt{136000} = \sqrt{(240 - 128X)^2 + (280 - 96X)^2}$$

and X equals 4½ hours.

Dividing by 2, we get 2¼ hours as the elapsed time in arriving at O.

In that 2¼ hours, Andy, traveling from the north, advances 48 miles beyond the intersection of their paths, while Bill, from the west, advances to a point 64 miles westward of that point of intersection.

Thus the distances from the point of intersection form sides of a right triangle, the hypotenuse of which, the distance between them, is 80 miles. Traveling for 2¼ hours, they must have reached that closest point at 2:15 p.m.

Your Summer Trips Made Trouble Free

(*Continued from page* 314)

required to make a tire change depends somewhat upon the accessibility of tools, ease of jacking up the wheel, removal of flat and spare tires and release of the lock on the spare. If the wheel is lifted by placing the jack as far outward as possible, as shown in Fig. 4, the load is much reduced and the jack holds better in soft ground. If the tire lock has been periodically oiled, no trouble will be had in opening. A drop of oil on each lug bolt and nut will be found of assistance. The carrier of the spare may be sprung if the car has been backed into bumpers or walls. Under this condition it may require the services of a repairman to remove it. Avoidance of striking the spare tire rack heavily, along with a little grease at contact points between the tire rim and rack, is an insurance against an immovable spare tire.

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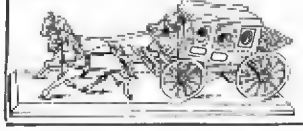

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Scientific Book Reviews

MODERN DIESEL ENGINE PRACTICE, by Orville Adams. Published by the Norman W. Henley Publishing Co., New York City, 656 pages.

The extensive use of the Diesel engine necessitated the publishing of a work that would detail the experiences of different industries with the various types of engines. With such a ready reference book at hand the inquiring technician will be able to find out exactly what engine is most practical for his needs, what difficulties might be expected in its operation, how these obstacles may be overcome and how to maintain and repair most economically the units that are in operation.

Mr. Adams' book most adequately fills that need. We ascribe a good deal of the effectiveness of the reading matter to the manner in which it is presented. Mr. Adams seems to regard a Diesel engine as an object that can best be understood by picking it apart and learning exactly what each minute particle consists of, where it is positioned and of what material it is made. The illustrations are clear and we are glad to say plentiful.

MASTER MINDS OF MODERN SCIENCE, by T. C. Bridges and H. H. Tiltman. Published by the Dial Press, New York City, 278 pages. Price $3.00.

The book before us is entitled "Master Minds of Modern Science." In that title lies the text for an entire sermon, or even a complete philosophy. The discussion does not center about the physical accomplishments of the men cited in the text but focuses our attention upon their minds. We do not see technicians and inventors but thinking, living beings, each confronted with a certain specific problem and eventually solving the enigma.

The chapter on Sir Jagadis Bose is practically a treatise on the ability of the human mind to project itself into a plant body and comprehend and evaluate the reactions of that form of matter; the discoverers of radium are the subjects of a dramatic story in which is featured their intense devotion to their study, from which no amount of suffering and privation could swerve them. The sketches of John L. Baird, Dr. R. A. Millikan, Albert Einstein, and others are really very well presented descriptions of the triumphs of human endeavor. As we read labor-saving devices take shape; a new astral philosophy is born which accounts for the movements of the universe; an improved technique of medical treatment is developed. But above all we are led to feel that mankind is the center of interest—that the individual technical problem is of no moment.

Contemporary literature teaches on the other hand that we are living in a machine age, and many of us have come to the conclusion that the earth is about to enter a Robot Period in which automatons will perform our many labors, mind will no longer be necessary to control actions that will be entirely automatic, and human will and consciousness will be of the dim and forgotten past. But the seers who predict the coming era forget or do not realize that an existence of this nature can never be, because the very factors that are necessary for its birth and furtherance prohibit and limit its growth.

The uncanny mechanisms that excite our wonder and supplant our hands and brawny shoulders are not parentless. They are the children of fertile science, visible effects of practical thinking, monuments, lasting or ephemeral, of man's inventive genius. The minds that produce such works will not molder or atrophy because of the burden the well-run machine lifts from the shoulders. The brain, that builds cunning devices, will continue to perfect and devise, and it will be a human brain in a human body endowed with human sympathies and human desires.

The gears and wheels which we are grinding out in our factories can never be substituted for the convolutions of the human brain. The well-trained mind, not the smooth-running machine, will govern our daily program.

GOLDFISH VARIETIES AND TROPICAL AQUARIUM FISHES, by William T. Innes. Published by Innes and Sons, Philadelphia, Pa., 306 pages. Price $4.00.

The former President of the Aquarium Society of Philadelphia, William T. Innes, has prepared a very creditable work on the subject of the title of the book. The work is profusely illustrated with line drawings and photographs and the angle of approach to Aquatic Plants, Foods, Construction of Aquaria and Aquarium Appliances, and the treatment of native aquarium fishes and goldfish, is remarkably full and comprehensive.

Unfortunately, tropical fish fanciers have long desired information on the subject of these toy fish. Innes' book illustrates most of the tropical fish both photographically and in color, but the story of these fish is not treated as fully as is the section on goldfish. True, the main facts are covered in captions under the photos, and a descriptive key covers the groups, but even at that, the information is meager. But in justice to the author, we must state that the work contains more data on tropicals than any which we have read. Every newcomer to the field of tropical fish culture will welcome the book.

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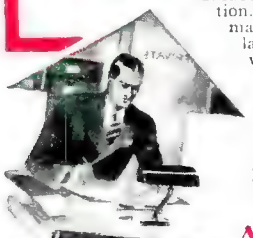

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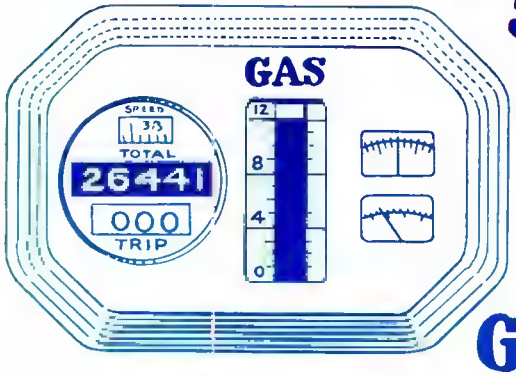

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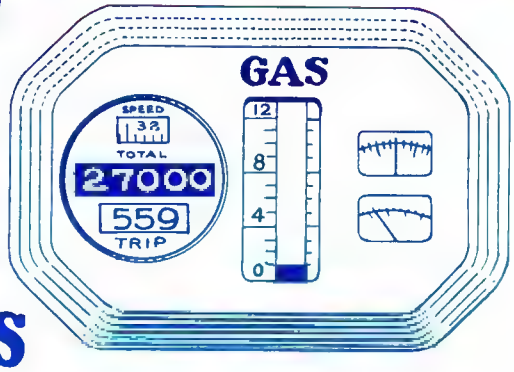

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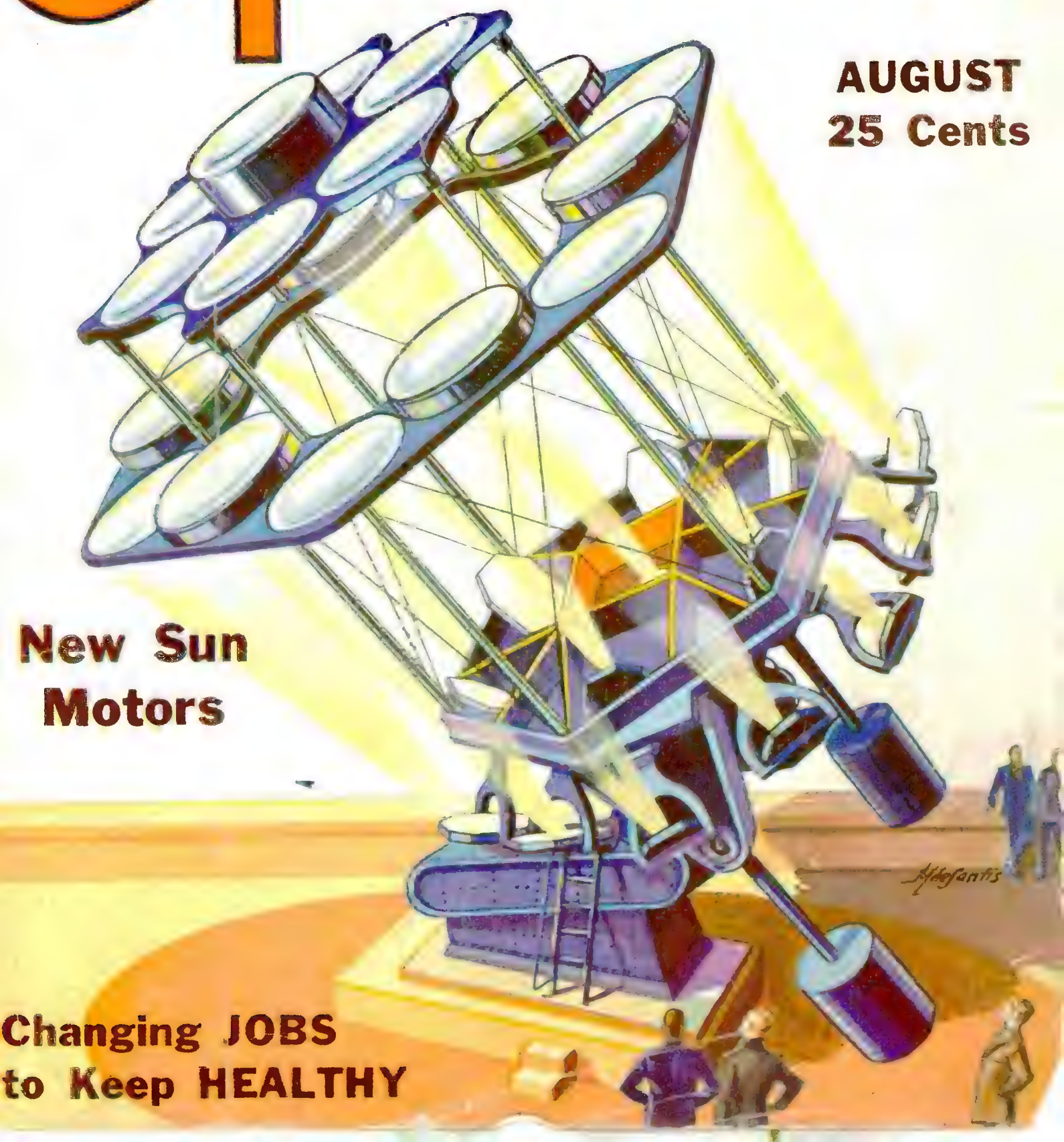

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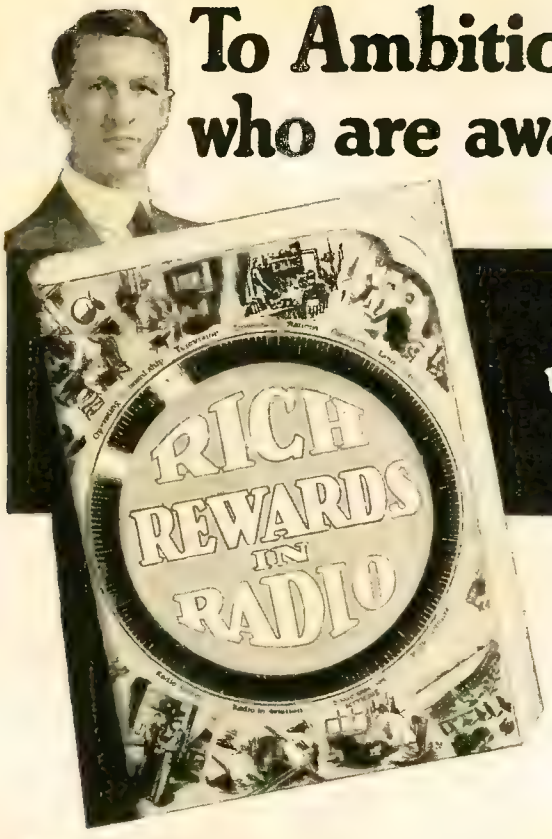

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Published Monthly by **Radio-Science Publications, Inc.**, Jamaica, N. Y.

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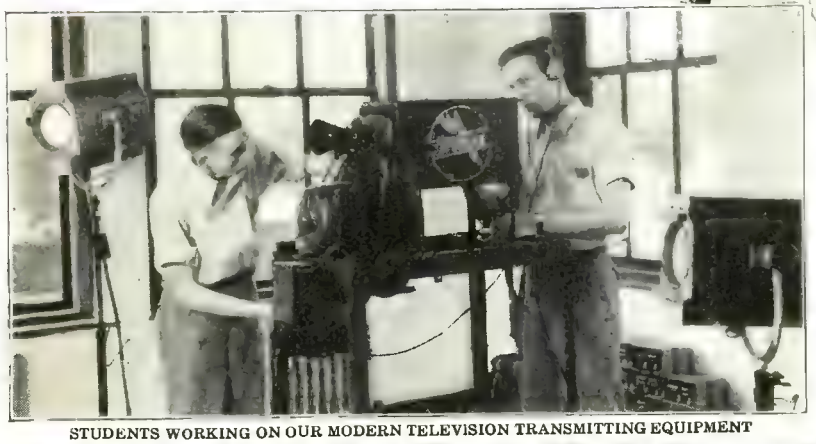

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Photo Ewing Galloway

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AUGUST, 1931
WHOLE NO. 220

Science and Invention

NUMBER 4
VOLUME XIX

Published by Radio-Science Publications, Inc., 381 Fourth Ave., New York City, N. Y.

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Editorial

MANY of the ills to which human flesh is heir have been found to be directly traceable to defects in diet. For example, Doctors G. B. Eusterman and O. P. O'Leary of the Mayo Clinic, reporting recently on a series of cases, showed that lesions in the digestive tract develop prior to a secondary pellagra—an endemic skin disease sometimes called "Italian Leprosy." It has been further established that a characteristic of vitamin "A" deficiency, known as xerophthalmia, is secondary to inability to digest and absorb food. Xerophthalmia is an inflammation of the delicate membrane that lines the eyes; with wasting away, and with abnormally dry and lustrous eyeballs.

So, perhaps medical science will ultimately correct digestive disorders by the daily administration of the known vitamins and others yet to be discovered. Perhaps, the proper doses of vitamin will make for the formation of perfect teeth and bones; and when medical science gets thus far, it will be possible for members of the fraternity to stop the growth of bones whenever they desire and so produce beings of relatively even height and weight. They may even delay the growth of hands and feet, so that members of our fairer sex will all present perfect appendages.

Improbable today, you will say. Yes, but not impossible.

IN the April, 1931, issue of this publication, Sir Ambrose Fleming, F.R.S., in his article entitled: "My Wireless Memories and Inventions," referring to his invention of the Fleming valve, wrote:—

"As a claim has been made by Irving Langmuir to have made a patentable improvement by making the vacuum a high one, I should like to point out that in my original patent specifications for this valve, the necessity for a high vacuum is clearly stated."

Sir Ambrose Fleming then quotes from his U. S. patent specifications, dated April 19, 1905, to prove this point.

On May 25th last, the DeForest Radio Company won a suit against the General Electric Company, which controls the Langmuir patent. It was decided by the court that "It did not need the genius of the inventor to recognize and act upon the truth that a better tube for amplifying could be made by taking out the gas." Also . . . . "increase of vacuum in well-known devices was all that was necessary to produce the desired result."

This decision makes the Langmuir patent invalid because of anticipation, want of invention, prior invention and prior use.

It is a good thing for our budding inventors to know that these requisites make for a basic patent

OUT in California, the broadcasting stations have developed their own censorship. Soothsayers and mystics who deliver fortunes over the air have felt this censorship. They have a radio newspaper, "California Broadcaster," to take up the cudgels for the public.

Now, if some of the stations on the East Coast would censor their programs more, and delete some of the advertising which is extremely obnoxious to the listener-in, and if they would also throw out those medical quacks whose advertising will not be accepted by reputable newspapers and magazines, and clean up the would-be mystics, the air would become peaceful and enjoyable again.

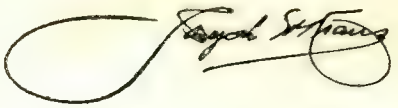
NO sooner does science develop a new food or ingredient of food, than the entire country grasps the straw, inscribes it as a panacea for all ills, and capitalizes upon the efforts made by men who are earnestly trying to discover benefits to human bodies.

Not so long ago electricity and magnetism were advertised as cures. There were electric belts, electric hair growers, magnetic and electrical combs, electric insoles for foot troubles, etc. Then these things died out and other frauds were perpetrated, such as the Oxydonor, Oxypathor and Oxybon. These were small metal tubes, which were to be placed in a basin of water where they "extracted the oxygen from the water," and fed it to the body through a rubber tube held in contact with the skin. Then glandular extracts of all kinds became panaceas. Following these preparations we arrived at the electro-magnetic belts, such as the Ionaca. It now seems that the sun-ray devices will enter into the field heretofore held by other alleged cures. Fortunately, sun-rays possess properties that are of distinct benefit. This is not so with frauds of the past. But sun-ray machines are not cure-alls.

To show the ridiculous extent to which these things are played up to the public, there is a laundry in Chicago that is subjecting all clothes to sun-ray treatment, after the materials have been thoroughly washed in boiling hot water to which ammonia may have been added, rinsed and dried.

So now, in addition to tobacco, bread, ice cream and cereals being sun-rayed, we may also have clothes, collar buttons and socks treated with ultra-violet light so that these items might also acquire health-giving properties.

Isn't this linen treatment exploiting science too far?



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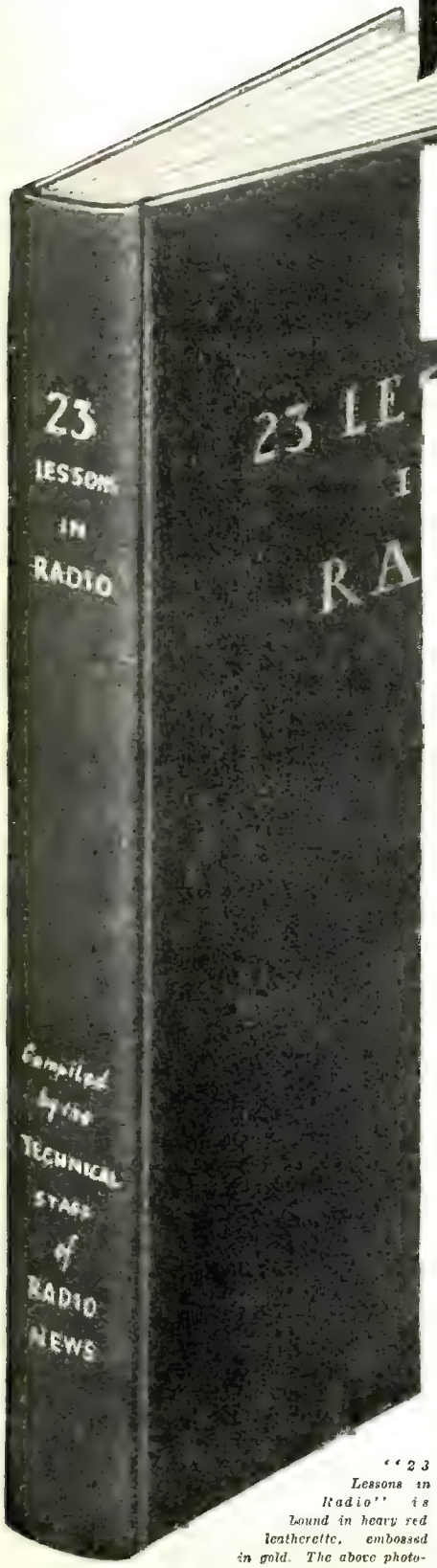

"23 Lessons in Radio" is bound in heavy red leatherette, embossed in gold. The above photograph is actual size.

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How To Build R F Tuner
How To Build a 3-stage resistance coupled audio-frequency amplifier
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AUGUST, 1931
WHOLE NO. 220

Science and Invention

VOLUME XIX
NUMBER 4

Changing Jobs To Keep Healthy

"Shall I Change My Occupation? By All Means! If Your Occupation Is Unhealthy, It Needs Remaking According to Hygienic Standards," Says the Author of This Amusing and informative Article. "Every Occupation Is Unhealthy. But if You Know the Secret of Industrial Hygiene, You Can Snap Your Fingers at Occupational Disease."

By Dr. Frederic Damrau, M.D.

As healthy as a sailor. The picture conjures up a ruddy-cheeked, brawny-armed gob with hair on his chest. But those who follow the sea can tell us best how sailors really live.

"You are going to make him a sailor, I judge," I commented to the officer of a freighter a few years ago, as his son passed us on the street. "Not him!" was the reply. "If I have anything to say about it, I shall never permit a son of mine to follow the sea. It's too unhealthy."

The grass always seems greener in somebody else's yard. Or perhaps I should say the waves are bluer under somebody else's ship. Yet, when I took a short trip aboard my friend's freighter, I found out what he meant. As an experience, the trip was a landlubber's adventure; but if I must go down to the sea in ships again, it will be as a passenger.

The sailors bunked in overcrowded and dirty quarters, with practically no ventilation. Their bunks were always damp and chilly. There were no facilities for keeping clean. The food was poor, swimming in grease and eaten on the run.

No wonder the old-time sailor seized every opportunity to hop ashore with a bottle of whisky under one arm and a lady of indifferent morals on the other.

Legislation is gradually improving conditions such as these, but because of them it is easily understood why pneumonia and tuberculosis prevail among sailors on freighters.

Girl workers in an English bottling factory are protected against exploding bottles by wire masks and thick woolen gloves.

If you chose your occupation as most people do, you followed the lead of your immediate friends or relatives. Another motive was, perhaps, the amount of money or the social position you thought would accrue to you. It is just as well, perhaps, that these were your motives, for if you attempted to choose what you considered an entirely healthy occupation it might take you a long time to catch your will-o'-the-wisp.

Once there was a jovial rover who said he would try anything once. He tried mining, and got anthracosis. So he gave up mining, took a job as policeman and got varicose veins. He gave up his beat to go into farming on sunny, southern acres. One day he went barefooted in the fields and got hookworm disease. Determined to find a healthful occupation, he gave up all jobs and became a hobo.

"Now here ought to be a healthy occupation," he mused, "plenty of sunshine and fresh air with nary a worry to speak of." But when heating his mulligan over a wayside fire, the wind swirled the smoke about him. Soon he began to get all hot and bothered. His face and hands swelled up and he broke out into torturing, itching tetters. Of course he didn't know it was poison oak he burned, and that the smoke carried the resinous irritant, *toxicodendrol*.

Our jovial rover next got sense, took up the occupation which interested him most and lived happily ever after, or at least his allotted three score and ten. He had discovered the secret formula. You remember the doggerel:

"Big fleas have little fleas upon their backs to bite 'em.
And lesser fleas have smaller fleas, and so *ad infinitum*."

Coal miner wearing goggles and an electric headlamp, both safety measures.

So it is with occupations. Every occupation is unhealthy. But if you know the secret formula of industrial hygiene, you can snap your fingers at occupational disease.

There are but a few general classifications required to explain the most spectacular dangers you may encounter when you go to work. Occupations which generate dust are notorious breeders of ill-health. Injurious vapors and the handling of highly poisonous chemicals in certain manufacturing processes engender specific and oftentimes terrible diseases. Such was "phossy jaw," which caused such shocking and painful disfigurement in match-makers, before legislation curtailed the manufacture of white phosphorus matches.

Unusual temperatures and atmospheric pressure may cause illness. Excessive use or friction of a portion of the body may cause a fatigue neurosis or local irritation. With such as slaughterers, skin-dressers, wool-, hair-, and rag-sorters, exposure to infectious, contagious and parasitic diseases is always imminent.

"Ballet dancers sometimes suffer severe spasmodic pain from over-development and partial dislocation of the great toe."

The surprising fact is that an industry which appears especially hazardous is oftentimes one of the healthiest. I was one of a party being escorted through a large coal mine near Scranton last fall. when a lady remarked to the physician in charge: "I should think miners would be especially prone to tuberculosis, working underground so continuously."

"On the contrary," he replied, "coal miners are three times as free from tuberculosis as other people. Strange to say, inhaling coal dust tends to protect lungs from t. b."

If you want to choose the healthiest occupation, be a clergyman. "Of the learned professions," says Doctor W. Ogle, "and indeed of all the occupations in our table, the Church enjoys the lowest death-rate." If the ecclesiastical calling has a characteristic ailment, it is clergyman's sore throat from exhortation against sin.

Next to the clergy, agricultural pursuits lead the list of healthful occupations. If you are a farmer, a horticulturist, a market-gardener or forester, start laying up your pennies against your old age, for you are promised many birthdays.

One of the queer occupational hazards which came to my attention a few years ago was "stamp-licker's tongue." The stamp-licker was employed usually in thread mills and factories where labels were utilized. One experienced lady "licker" could lick as many as eighty-five gross of labels a day.

The tongue of the stamp-licker always had a characteristic polished tip and frequently was the seat of small ulcers. Many of these girls suffered, also, from infected glands in the neck. Machinery competes with girls nowadays in stamp-licking, thus eliminating the above troubles.

Too little or too much air may be the undoing of those whose occupations cause them to work under unusual pres-

Ewing Galloway Photo

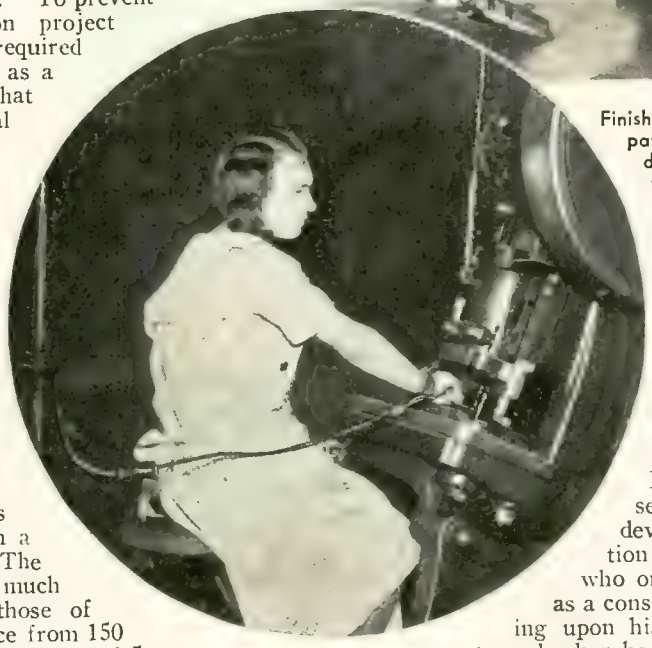
This gun applies cement to passage walls in coal mines to settle the coal particles and prevent explosions. It also helps to prevent miners' anthracosis, a disease of the lungs from breathing coal dust.

sure. At extremely high altitudes, the pressure is so diminished as to cause what the French call *"le mal des montagnes."* The worker whose occupation takes him to the high mountain top usually becomes acclimatized in a few weeks. Leonard Hill in his *Recent Advances in Physiology* reminds us that the highest dwelling place continuously occupied is the Observatory El Mirti, in the Andes, at three and one-half miles. He reminds us, also, that in Peru, Bolivia and Northern Chile a very large part of the population lives above two miles. Thousands visit the annual fair at Gartok in the Himalayas. This is 2.8 miles above sea level.

All construction engineers who work on projects where caissons are employed are familiar with caisson disease. It is caused by too quick a change from the increased pressure in the caissons back to normal atmospheric pressure. One of the serious symptoms is excruciating muscular pain. The workmen call this the "bends." To prevent this disease, every construction project working with caissons should be required to have decompression chambers as a part of the regular equipment, so that workmen may return to normal pressure very gradually.

One of the penalties of the machine age is the strain which monotony places upon the worker. Long repetition of a single movement sometimes produces the fatigue neurosis called occupational cramp.

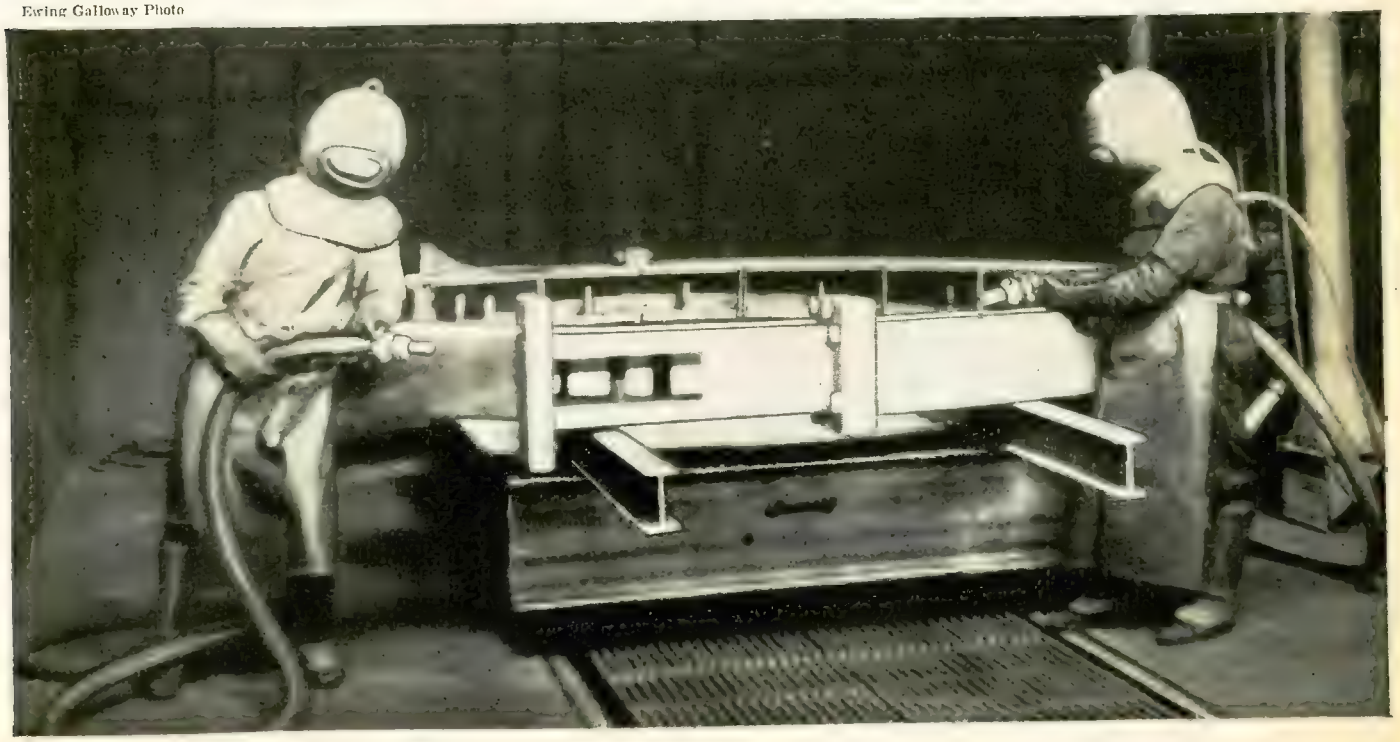
Dr. Charles Aldrich, neurologist to the Cleveland General Hospital, was consulted some time ago by a man who complained of cramp-like pains, numbness and intermittent paralysis in the muscles of his right leg. When asked his occupation he said he had been a trap-drummer for twenty years. The muscles of his right leg were much more highly developed than those of his left leg, as they had to produce from 150 to 180 strokes per minute at a pressure of 5 to 25 pounds for each stroke. He was suffering from occupational cramp, which is caused by sustained, repeated movements requiring keen mental attention. His recovery was effected by gradually educating his left leg to relieve his right leg. A similar fatigue neurosis is the one called "dentists' leg," caused by standing continually in a strained position. Ballet dancers sometimes suffer severe spasmodic pain from overdevelopment and partial dislocation of the great toe. A boiler-maker who once called at my office was deaf as a consequence of the repeated hammering upon his ear drums. His hearing returned when he left the boiler-shop and became a prize fighter. But then he got cauliflower ears. Shall I change my occupation? By all means! If your occupation is unhealthy, it needs remaking according to hygienic standards. If you are a (*Continued on page* 350)



Finishing off a tennis court by means of a patent preparation which gives off a deadly gas. The workman is protected by a mask and glove. Left—When the operator of this punch press depresses the foot lever which releases the stamp, the cable attached to her wrist draws her hand back, thus preventing its accidental mutilation.

Divers' helmets protect these sand blasters from inhaling irritating particles while they clean steel machinery.

Ewing Galloway Photo



Experiments Prove Aurora Theories

By A. Dinsdale

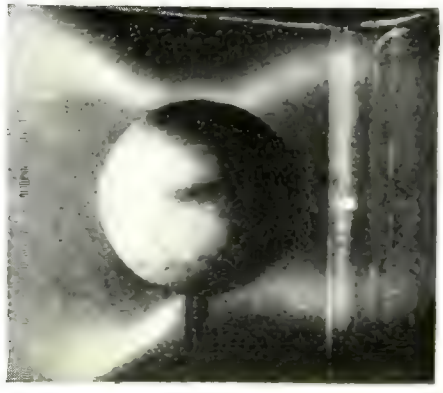
PRACTICALLY everyone living in the northern hemisphere has at some time or another seen the Aurora Borealis, or Northern Lights. It is impossible to watch the beautiful shapes and colors of this phenomenon without wondering about the cause or causes, and scientists who have been engaged upon the problem for many years have now proved beyond reasonable doubt that the cause is entirely electrical. Briefly outlined, the explanation of the Aurora is as follows. The sun is continually radiating electrons, which reach the outer limits of the earth's atmosphere after traversing the intervening vacuum—just as the electrons emitted from the filament of a radio tube traverse the vacuum and reach the plate. But when these electrons reach the beginnings of our atmosphere, 300 or 400 miles above the earth, the flying electrons collide with atoms of gas, producing ionization (electrification) of the gaseous layers (Heaviside Layer). Each collision also produces a flash of light, just as in exactly similar circumstances light is produced in Geissler, neon, or other gas discharge tubes.

Experimental demonstration of the manner in which an electron stream approaches a pole of the magnetized earth. The electrons are deflected away from the pole. Upper right inset—A cathode ray tube for producing an electron stream. The magnet at left deflects the electron stream. Left—Experimental demonstration of the periodic path of electrons round the equator.

This theory was first propounded by Birkeland in 1896, and by 1904 the Norwegian scientist, Störmer, had worked out the theory on a mathematical basis.

There remains to be explained the peculiar shapes which the Aurora takes. These are caused by the influence which the earth's magnetic field has on the streams of electrons. It is well known that a stream of electrons, in the form of a cathode ray, for example, can be bent aside from its straight path by means of a magnetic field. It is possible also to cause a stream of electrons to spiral around a line of magnetic force. The most important of all paths which exist in the magnetic field of a magnetic element is the circular path which in the equatorial plane is concentric with the equator. With reference to our earth, it is further removed than the orbit of the moon. Exactly in the middle space between it and the earth is the frontier of an unelectrified region which surrounds the earth like a pad. From above and below, the electrons approach the polar region of the earth on complicated paths. Going down through the atmosphere the rays which originally had cir-

(*Continued on page* 346)

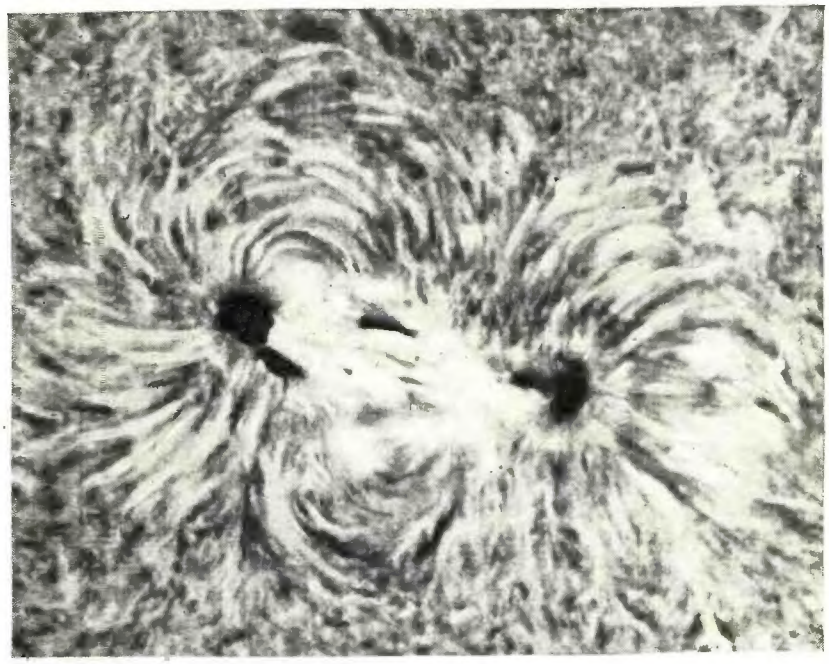


Left—Showing the influence of a circular current on the point of impact of the electrons. Right—Polar light experimental model used by Birkeland.

Whirlwinds on the Sun

These Gigantic Whirlwinds, Counterparts of Terrestrial Tornadoes, Prove That the Sun's Surface Is in a Violent State of Tumult. They Are So Huge That a Body the Size of the Earth Would Be Swallowed Up and Lost Inside One of Them

By Donald H. Menzel, Ph.D.
Lick Observatory, Mt. Hamilton, California



Sun-spots frequently occur in pairs, each member rotating in an opposite direction. The curved penumbra shows the cyclonic motion.

THROUGH our telescopes we can see that the surface of the sun is in a state of violent agitation. The fiery gases seethe and whirl continuously. Occasionally the tumult becomes so great that jets of matter, like spray from a gigantic wave breaking upon a rock-bound coast, are tossed thousands of miles out into space. In the hot solar atmosphere we find the counterparts of terrestrial tornadoes, but on so large a scale that a body the size of our earth would be lost inside the limits of the whirlwind. Storms! Within an atmosphere where the gases are at a temperature of 6000° centigrade (11,000° F.)! Where 50,000-mile-an-hour gales are frequent and where 100-mile-an-hour winds constitute stagnation! No wonder, the sun is so interesting an object for astronomical study.

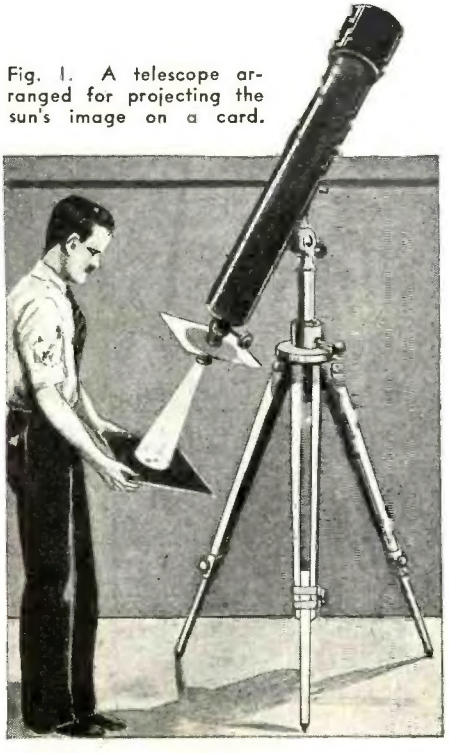


Fig. 1. A telescope arranged for projecting the sun's image on a card.

Aristotle taught that the sun was composed of virgin fire, a theory apparently so in keeping with the sun's rôle as ruler of the day and giver of life, that belief in the purity of the sun became a fundamental ecclesiastical doctrine. Therefore, when Galileo, in 1609, turned his newly invented telescope upon the sun's shining disk and found it to possess numerous dark spots, his announcement of the discovery brought him into great disfavor with the church. The sun, being of pure fire, could not possibly possess spots! The spots seen by Galileo, if not motes in his own eye, were probably merely birds!

Patiently Galileo met the objections. He showed that the motions of the spots across the solar surface did not in the least resemble the erratic flying of birds. He also proved that the objects could not possibly be in the earth's atmosphere. Then, his antagonists averred, perhaps the markings were hitherto undiscovered planets, whose dark disks were projected against the sun's. Galileo replied that the spots frequently changed size and shape, and that their rates of motion were in accord with their being actually a part of the sun. The well meaning but bigoted prelates, confuted by their own arguments, had no recourse but to pronounce the telescope an invention of the devil and to warn the laity against looking through it lest they,

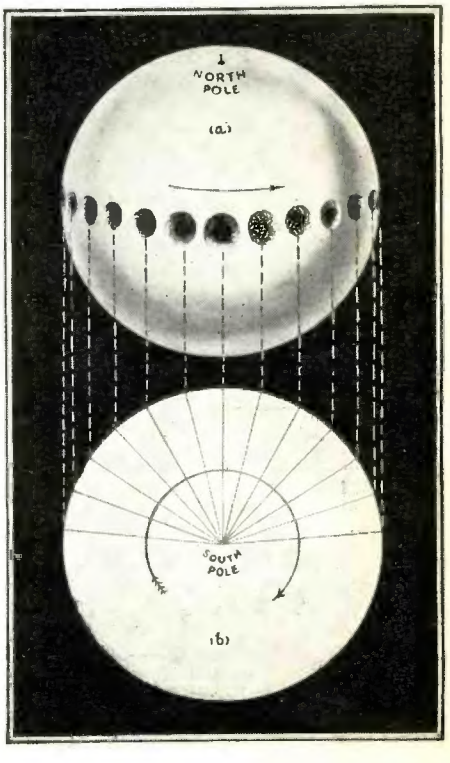


Fig. 2 (right). Solar rotation shown by position of spots on successive days. The spots are depressions in the sun's surface.

Courtesy U. S. Dept. of Agriculture

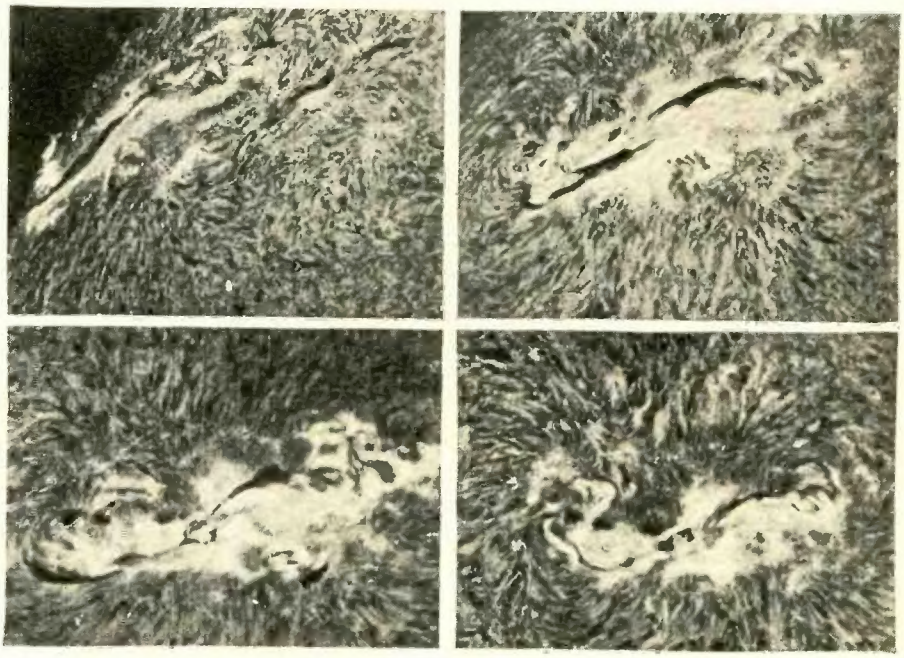
Here is a tornado cloud, the earthly analogue of the sun-spot. Below—Four views of a sun-spot taken at two-day intervals. Note the trace of ejected matter extending above the spot in the upper left-hand photo.

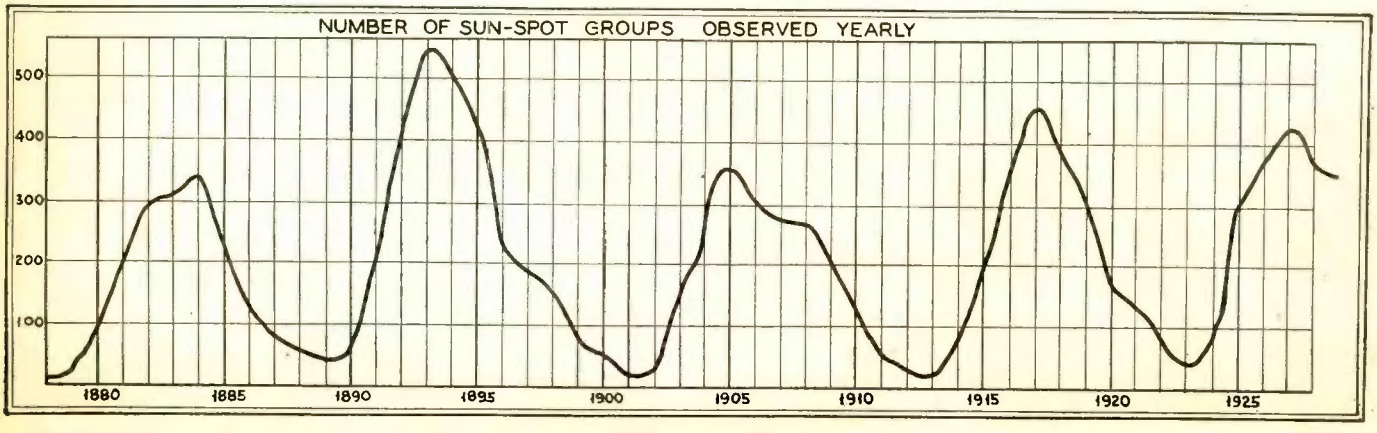
too, should become bewitched and see sights that common sense told them could not be real. But ecclesiastical ban could not long prevail against the "witchery" of science, and the solar nature of the spots eventually was established.

See the sun-spots for yourself! No elaborate equipment is required. Field glasses, a small pocket telescope, even opera glasses will suffice to show the larger ones. To protect the eyes from the blazing sunlight, a piece of smoked glass, or a fogged photographic plate should be mounted in front of the objective lenses. For large instruments it is more practical to mount the dark glass in back of the eyepiece. With a little persistence, even with such modest instruments as these, anyone can perform several very instructive observations. It is interesting as well as amusing to keep a daily record of sun-spots. This may be done by drawing a circle to represent the sun and sketching in the spots free-hand. A more accurate chart can be made by mounting the telescope as shown in Fig. 1. No dark glass is used in this arrangement. The eyepiece is pulled out an eighth of an inch or so beyond its customary focus and a piece of cardboard placed about a foot behind the end of the tube receives an image of the sun. The best focus is determined by adjusting both the eyepiece and the distance of the card from the telescope. The farther the card from the instrument, the larger will be the solar disk. The purpose of the card mounted on the tube is to throw the other card into shadow, so that the details of the solar surface can be studied.

Almost immediately it will become apparent that the sun is rotating about an axis. A composite drawing made from a series of diagrams is given in Fig. 2a. It shows successive positions of the same spot at intervals of one day. The apparently more rapid motion near the center of the disk is an effect of perspective. The spot actually is moving uniformly, as shown in Fig. 2b which is drawn looking down upon the sun's south pole. From the fact that it takes about thirteen and a half days for a spot to cross from one side of the disk to the other, we conclude that the sun's rotation period is twenty-seven days. When corrections for the motion of the earth are introduced, the true rotation period* comes out about 24.65 days. This figure is for a spot exactly on the solar equator. If our spot had been at latitude 30°, it would have taken fully a day longer to make its circuit, while if it had been at 45° almost two days longer would have been required. The sun evidently does not turn like a solid body. If, as (*Continued on page* 330)

*The period we would obtain if the earth were stationary. In the elapsed four weeks, the earth completes about one-thirteenth of a revolution. Hence, the observed period is about one-thirteenth too long.





Plants That Act Like Humans

Not Such a Preposterous Idea Either, as You Will Undoubtedly Agree When You Have Read This Fascinating Article

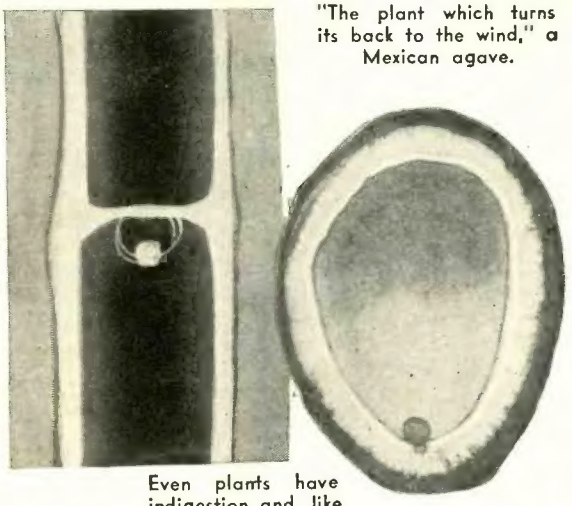
By S. Leonard Bastin

CAN plants think? Can they feel like human beings? Can they express themselves? Are they capable of offensive and defensive action as we are?

These and a dozen other questions must inevitably occur to anyone who has spent a great deal of time in the close study of plant life. In preparing this article I have selected just a few of Nature's curiosities of the plant world.

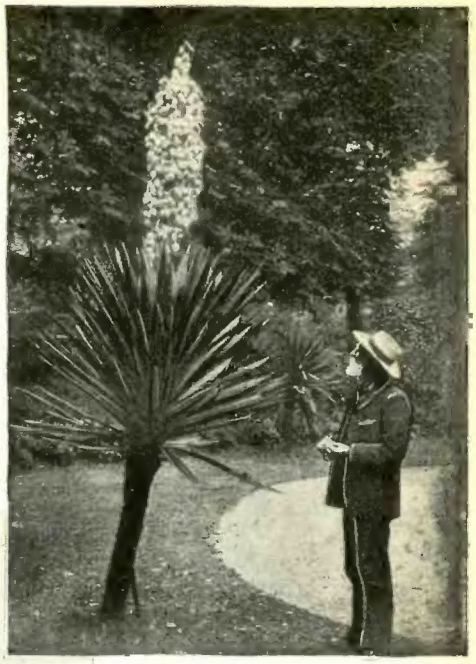
Mexico is a land of strange plants, which are curious because they have had to adapt themselves to the climate in which they live. Much of Mexico is semi-desert region, where rain only falls at rare intervals and the vegetation is largely of a succulent nature. Cacti, agaves and aloes abound.

One agave which always attracts attention is known as "the plant which turns its back to the wind." This plant grows in desert regions where, at certain seasons of the year, a hot, dry and extremely strong wind blows. The wind gathers clouds of sand with it, and this sand would so collect in the cavities between the leaves of the agave that the plant would be absolutely choked. The plant has surmounted this difficult problem of self-defense by the simple expedient of always turning its back to the quarter from which the wind blows. As can be seen from the accompanying photograph, the heart of the agave is completely sheltered by the clustering leaves, and no sand can work its way into the interior.



"The plant which turns its back to the wind," a Mexican agave.

Few people realize that the handsome yuccas depend for their very existence



The handsome yucca, which depends for its existence upon co-operation with a tiny moth.

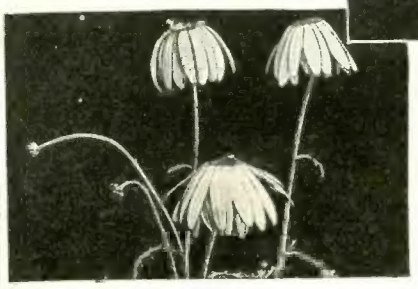
on certain little white moths belonging to the genus *Pronuba*. During the daytime these moths, either singly or in pairs, can be found resting with folded wings within the half-closed flowers. After sunset they are to be seen flitting about from plant to plant and from flower to flower. This is the male insect, for the female is busily at work most of the time inside the flowers. Indeed, she has very little time for any aimless flying around. She has to carry out the duty of continuing her race, and she must also act as foster mother to the plant in order to secure a proper supply of food for her grubs which feed on yucca seeds.

The female moth becomes very active soon after dark, and she at first busies herself collecting a lot of pollen. She may be seen running to the top of one of the stamens, hard at work scraping the pollen grains towards the organs about her mouth. After gathering a sufficient supply, and shaping this into a ball about three times as big as her own head, she sets off for another flower.

On entering the new flower the moth plunges her lance-

(*Continued on page* 342)

Even plants have indigestion and, like pearl oysters, produce a very hard, stony substance. Growers of bamboos, when they split canes, frequently find these stones deposited at the joints. Similar stones may be found in coconuts.



Humans and animals are not alone in their unpleasant reaction to rough seas. The photograph, upper right, was taken of some marguerites on a liner during calm weather, and the second picture of the same flowers, taken during rough weather, suggests that they are seasick. Left—Some flowers, like the nasturtiums shown here, become luminous at night some hours ahead of a thunderstorm.

A pearl shell, showing location of pearl.

Pearls—The an Oyster's

The Author of This Article Recently Completed an Investigation of the Pearl-Fishing Industry in the Dutch East Indies, and Tells a Fascinating Story of the Way in Which Pearls Are Formed and Found. Although Pearls Represent Good Luck to the Human Finder, They Are, According to the Author, the Product of the Oyster's Hard Luck

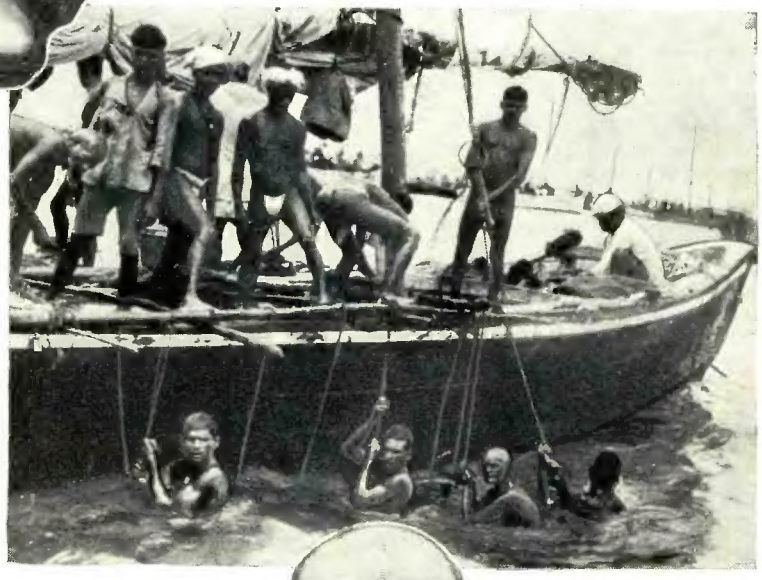
STENCH and Pearls. Who would ever associate that coveted treasure which graces milady's neck with a putrefying odor? Unfortunately the association exists. No more disgusting spectacle can be imagined than that of a crowd of natives employed upon the loathsome work of digging for pearls, with their arms buried into a hideous mass of corruption and filthiness, amid a horrible, putrid stench.

These thoughts raged through my mind as the small steamer that was plying between the Molucca and Arue islands off the coast of Dutch New Guinea, took me back, after a fortnight's stay with the pearl fishing fleet, to more civilized and less odorous realms.

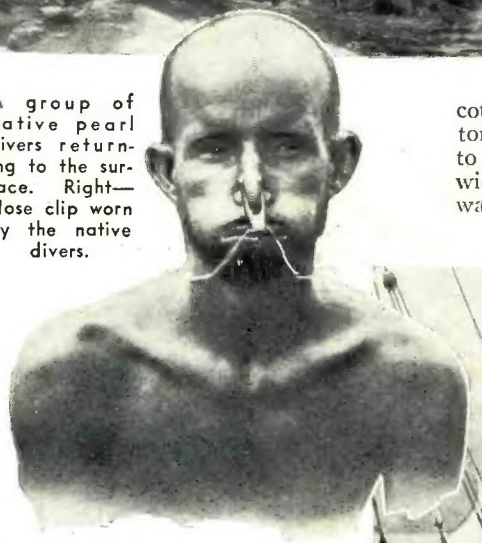
I had been an interested visitor on an investigating mission of the pearl fisheries off these islands, my work being concerned with the development and peculiar habits of this most valuable of all molluscs. I also endeavored to get a glimpse into the life history and natural habits of the mother-of-a-pearl shell, the *Margaritifera* species, the leading variety found throughout the Australian, Polynesian and Far Eastern waters.

The pearling season takes place in the West Moesson, or West Wind Season, because at other times of the year the waters are too turbulent. The boat on which I was the highly interested passenger was of the lugger type, manned with eight brawny Manilarese (the divers par excellence) and supplemented by a number of Japanese. The fleet consisted of strong lugger-rigged craft, averaging some ten tons burden, assisted by cutters of large size which served as purveyors to our luggers, and also to bring the collected shell back to port.

The crew consisted of the divers, of which the headman took command, also acting as the sailing master. We had one tender, who also held the life line, attending to all signals from the divers while at work. There were some four or five working hands, who in pairs would take alternate shifts at the manual pumping apparatus for supplying the air to those divers who were supplied with diving suits.



A group of native pearl divers returning to the surface. Right—Nose clip worn by the native divers.



Right—The author coming up from his dive to the oyster beds, which he describes in the text.

While diving generally takes place in a rather primitive fashion, without the use of elaborate preliminaries, so customary on the better equipped expeditions, in our particular case we had both types of operation, one in which the divers went down naked and another in which the most up-to-date diving apparatus was used.

In cases where no diving suits are used, the divers go down stark naked, with greased bodies, greased cotton in their ears, a forked stick or tortoise shell clip upon their nostrils to compress them, and with a wide wicker basket or net attached to the waist.